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THE EXECUTIVE AND THE LABOR PROBLEM

By WHITING WILLIAMS*

I know four important rules of salesmanship: The first rule of good selling is, "Study and know your product." The second rule is, "Study and know your customer." The third rule is, "Study and know your customer some more." The fourth rule is, "Study and know your customer still more."

One reason why the employer has not done a better job of selling the employee within the last two or three years is that he has paid too much attention to his competitor, the outside labor leader, and too little attention to his customer, the wage earner right in his plant.

I find that the employer, the general public and the average legislator are all making the mistake of taking the labor leader more seriously than he deserves to be taken, while taking the ordinary, every day, typical American wage-earner much *less* seriously than he deserves to be taken.

I believe, therefore, that if any executive is going to avoid labor trouble he must understand, first of all, that the issues which separate him from his customer in the person of his wage earner, are not the big, class-wide, fundamental, historic, mysterious issues which the labor leader would like to persuade him they are. On the contrary, they are small, individual issues.

Next, he should perceive that this labor leader is the boss of the worker; the boss of the labor leader is the man who makes possible the prolongation and the continuation of that labor leader's job through the payment, month after month, of membership dues. The labor leader who wants to continue to be a labor leader permanently must have always in mind that he is a leader by reason of his ability to know just exactly how far his followers will follow him and also exactly how far they will *not* follow him.

It is true that since the days of NRA it has been easier than ever before for a labor leader with a small minority to start trouble. He has an advantage of mass or professional picketing—picketing by people who have no interest whatsoever in the particular difficulty. He also has the use of that new device called the flying squadron. He also has the advantage both of the free relief and of a new public opinion which makes it very difficult for the employer to gain police protection for those workers who would like to work.

While this leader and this small minority can *start* trouble more easily than ever before, they cannot *finish* that trouble successfully, cannot make gains calculated to obtain for this leader the permanent cooperation and following of the rank and file of the workers, unless this leader and this small minority enjoy either the secret or active cooperation of a much larger group of their fellow employees. This indispensable help of this indispensable near-majority is impossible except when the members of that much larger group have in their minds an accumulation of uncared for grievances. This aggregation of uncared for grievances is impossible, of course, where the management has been doing all it should to take care of worker grievances.

Managerial Procrastination

A couple of years ago I was called down to see what could be done about a five weeks' strike of a thousand men which had been threatening the very existence of a certain company. I was told by the manager that it was simply because, after they had been getting along well for years and years, an agitator had come in and made trouble. But after I was introduced to the committee of his own employees, I had to go back to the manager and say, "These men tell me that, before the strike, they were appointed by 45 craftsmen of your thousand men to ask you whether three cents an hour had really been given to craftsmen of the same sort in another factory in the same district. They tell me that they looked for you but couldn't find you; that your representative assured them that the answer would be given them in 24 hours, but that three days later no answer had been given and that then these 45 men became restive and wanted to walk out; that they were urged not to strike by the committee, but at the end of the fourth day, when no answer came, the 45 men walked out and the strike was on."

"Well," said the manager, "that is probably what happened. You see I have been in Washington a great deal and it looks as though I hadn't properly allocated responsibility." No mystery, no historic class struggle, nothing except a plain case of what is well-called "managerial stall-itis."

Later on I was asked to find out why it was that the workers in a small plant in a small town had suddenly gone wild and joined an outside belligerent group. The reason was that during the depth of the depression, the company, in order to save money, had done away with the plant superintendent and the employment manager, with the perfectly natural result that every foreman in every department made it perfectly plain that nobody could hold his job without showing himself very, very much that foreman's friend. Therefore, everybody, to protect himself against being laid off next morning, at a time when to be laid off was the supreme calamity, had to hire a protector on the outside against the favoritism of the boss. Nothing but a case of "foreman-itis."

Still later, I went to a mass meeting in Michigan. A hundred and fifty people were there. Why? Simply because the day before a certain assembly line, consisting

*From an address before the Glass Container Association, May, 1937.

of 150 people (every one at this meeting), had been told that its efficiency for the day before had come down to 85, whereas the week before it was 115. They could not figure out how they could get 85 yesterday if they got 115 last week. They went to the foreman, who said, "I don't know." He was very busy and went on handling something else. They went to the shop committeeman in that department. He said he didn't know. Then they went to a radical who had been trying for years to make trouble in that department, and he said exactly what these other two chaps had their chance to say but failed to say, "I don't know, but I'll damn soon find out!"

Strategy Forestalled Trouble

My point about the importance of the individual and the importance to this individual of what, after all, are comparatively minor items, is made plain by the story of a friend who said he had been called down to a suburb of Cleveland, where there had been a strike of five hundred employees, and where the situation was getting more and more desperate every day.

"I never saw such a bad-tempered committee," he stated as he sat down opposite me—after they had shoved across the table a sheaf of papers with the words: "There, Mr. Vice-President, are 42 demands, and not until every one of these 42 demands is granted will one single individual cross the picket line alive."

"I had been taught," he went on, "that these issues between labor and capital were very large affairs. So I could not imagine how we could have allowed to stay there for ten years, as manager of this plant, a man who could have allowed great fundamental issues to develop to the number of forty-two.

"But I read demand No. 1. It had to do with the case of John Slovinski, who, after nineteen and a half years of service, was laid off on such-and-such a date, his job being given through favoritism to Bill Smith, possessing only one year's service. Demand No. 1 is for a rehearing of the case of John Slovinski.

"If that describes the case," I said to the manager, "I think we ought to give John Slovinski a re-hearing," and we so agreed. "Demand No. 2 had to do with Mary Brown, who, after so many years of service, etc., etc., etc." Believe it or not, 38 of those 42 demands had nothing to do with anything more historic, more class-wide, than the case of Bill and Frank and John and Jim and Mary and Gertie, all the way down the line—mostly with respect to their hold on the daily job. The other four were huge issues that would have required weeks of discussion by the Board of Directors and perhaps required changes in the Constitution of the United States. And what do you think that labor chairman said? "Well, we have been talking it over with the boys here and we say, to hell with the other four! We'll be back to work in the morning!" Those four demands were window dressing Big issues put in to make the whole thing look important to the outside world.

Get That 60 Per Cent

All that I have been observing indicates to me that in every labor group you can count upon 20 per cent of the workers who are very pro-company; another 20 per cent that is very pro-union; with the 60 per cent made up of every-day, typical, self-respecting, family-loving, church-going workers, who want to see the fair thing done and want to think well of themselves as holders of their jobs.

This near-majority, this middle group, never favors going outside to bring in some outside protector unless they have become convinced that there is no other way of getting their individual grievances fixed up. I am inclined to believe, therefore, that the ordinary leader, especially in those industries which have not hitherto been organized, lives off the crumbs of inefficiency in the handling of individual grievances which drop from the table of local management.

Security the Wish of All Workers

The wish for security, the need of a protector against the possibility of having a job or no job decided by favoritism is a paramount consideration in hard times. If you will look into the cases of the National Labor Relations Board and of the strikes about the country—if you will get down to the real causes you will find that they are due mostly to that one thing—the worker's fear for his job.

I have seen the whole labor situation changed just because it became possible as a result of the activities of management, perhaps with the help of the Shop Committee, for a man to go into his department and see there a list which meant that he didn't have to worry about being laid off or fired until Jack and Jim and Bill and Joe and Frank lower down on the list had first been laid off. Whereupon the need of an outside protector vanished, and the number of memberships in the outside union went down sharply.

Pride in Personal Worth Important to Worker

In good times and in bad, every worker wants to take pride in his job. The reason men everywhere pray for the daily job is not because it means a certain amount of money but because it means a certain amount of assurance about the value of one's personality in the whole scheme of things. You cannot understand, therefore, why the fear of losing the job is the terrible thing it is until you understand that every worker in the world has experienced the utter misery of joblessness which comes from his having no certification of any personal worth.

I learned that from my old friend, Evan Pugh, the repair man. There in the mines of the Rhondda valley, we'd await the word that would come every once in a while where we'd be doing some ordinary work of messing around with a pick and shovel. Finally a light would come through the darkness, the man carrying it would put it up in old Evan's face and a voice behind the light would say, "Be that you, Evan? The boss do say as how there's a very bad fall of rock in such-and-such a place. Come quick before the whole mine falls in!"

Sure enough, we'd go there and find a big rock fallen on the rails. After we had cleared away the rock and made the place safe again, and realized that because we had done our job then and only then could everyone else in the mine get busy. I can see the pride with which old Evan would put on his coat, take down his lamp and start back, calling over his shoulder to me, "Wull, it been plain to see they can't run the bloody old mine without you and me, now can they?"

Every job is like that. It has a sort of spiritual fringe that ties this job to the next and those two to the third and those three to the fourth job, until finally, through

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THE USE OF THE GEHLHOFF AND THOMAS SPECIFIC EFFECT DATA IN PRACTICE

When making a change from one glass composition to another it is often necessary or desirable to estimate what influence, and the magnitude of that influence, the proposed change will have on certain of the physical and mechanical properties of the resulting glass. In plants where composition changes are frequent, sufficient information is usually available for such estimates because the data is systematically collected after each composition change. In cases where changes in composition are seldom made and data is lacking, practical experience cannot be relied upon and other sources must be sought.

The extensive work conducted by Gehlhoff and Thomas (J. Tech. Phys. 1926, 7-105) on the effect of various glass forming oxides on the physical and mechanical properties of glass is, by far, the most systematic investigation on this subject to be found in the recent glass literature. In these investigations a simple soda-silica glass having the composition, 82 per cent silica, 18 per cent soda, was used as a parent glass and its various mechanical and physical properties measured. Several series of varying compositions were then produced from the parent glass by substituting various oxides for part of the silica. The properties of the new glasses were then measured and compared with the parent glass. The specific effect of each different oxide as it replaced the silica was thereby measured and calculated.

While the method used by Gehlhoff and Thomas does not give all the information required (it neither takes into account the effect of combinations of the various oxides, nor the effect of variations in the soda content) it does indicate however the effect of the replacement of part of the silica by other oxides. In many cases the procedure usually followed when changing formula is to replace part of the silica content of the glass with other oxides, keeping the soda content constant.

One of the more important physical properties that can be readily calculated from the data of Gehlhoff and Thomas is that of density. If the density of the glass that is to be changed and the composition of the new glass are both known, the use of the specific effect factors given in Table I will enable the density of the new glass to be calculated. The mathematics involved are quite simple and are illustrated in the example given in Table II.

These density factors are remarkably accurate when used on glasses of similar composition. Using the density value of the parent glass (obtained by actual measurement) and calculating the densities of a series in which lime replaces silica in five per cent increments, the relationship between density and lime content can be determined. This relationship is shown in Fig. 1. Data obtained by Peddle on a series which approximate very closely several of the glasses on the curve, show very good agreement when the slight difference in compositions is taken into account.

Not only do these factors hold good for simple three component glasses such as the above but good agreement is found when the calculated and measured densities of more complex glasses are compared. Using data given by Scholes (J. Amer. Cer. Soc. 1929, 12-753) on a series of compositions and their measured densities, the densities of the various glasses were calculated by use of the Gehlhoff and Thomas density factors. The glass composition and the measured and calculated densities are shown in Table III.

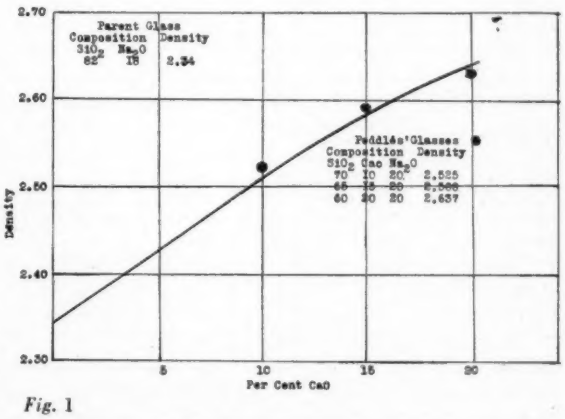

Fig. 1

TABLE NO. I.: DENSITY (According to Gehlhoff and Thomas)

Oxide	Parent Glass	0-5%	5-10%	10-15%	15-20%	20-25%	25-30%	30-40%	40-50%	50-60%
Na_2O	80 SiO_2 : 20 PbO	—	—	+0.017	+0.010	+0.008	+0.006	—	—	—
K_2O	" "	—	—	—	+0.005	+0.003	—	—	—	—
MgO	82 SiO_2 : 18 Na_2O	+0.012	+0.012	+0.006	0	—	—	—	—	—
CaO	" "	+0.018	+0.016	+0.014	+0.012	+0.009	+0.007	—	—	—
ZnO	" "	+0.021	+0.021	+0.021	+0.021	+0.021	+0.021	—	—	—
BaO	" "	+0.024	+0.024	+0.024	+0.024	+0.024	+0.024	+0.024	—	—
PbO	" "	+0.024	+0.024	+0.026	+0.027	+0.029	+0.032	+0.034	+0.037	—
B_2O_3	" "	+0.018	+0.010	+0.003	0	—0.004	—0.005	—0.005	—0.006	—0.006
Al_2O_3	" "	+0.006	+0.006	+0.006	—	—	—	—	—	—
Fe_2O_3	" "	+0.013	+0.013	+0.013	+0.013	+0.013	+0.013	—	—	—

TABLE II.: METHOD OF CALCULATING DENSITY
from the Gehlhoff and Thomas Table

Oxide	Parent Glass				New Glass
SiO_2	74.1	73.4	73.0	76.1	76.1
CaO	4.4	5.1	5.1	5.1	5.1
MgO	2.8	2.8	3.2	3.2	3.2
Al_2O_3	0.3	0.3	0.3	0.3	0.3
Na_2O	18.4	18.4	18.4	15.3	15.3
Density	2.461	+0.7×0.018	+0.4×0.012	—3.1×0.01 = 2.447	
				Measured—2.446	

Turning to the mechanical properties of glass, the data of Gehlhoff and Thomas will enable estimates of the effect of the various oxides to be made on properties such as compressive strength, scratch hardness, tensile strength, the modulus of elasticity and the bending strength. The specific effect data for these various properties will be pre-

TABLE III.: COMPARISON OF CALCULATED AND MEASURED DENSITIES

Composition	1	2	3	4	5	6	7
SiO_2	74.1	76.1	74.1	72.2	73.8	75.3	74.59
CaO	4.4	5.1	5.0	8.8	11.7	4.5	10.38
MgO	2.8	3.2	3.4	0.4	0.3	3.1	0.30
Al_2O_3	0.3	0.3	0.9	0.9	0.4	0.2	0.45
Na_2O	18.4	15.3	16.6	17.7	13.8	16.8	14.22
Density (measured)	2.461	2.446	2.461	2.501	2.498	2.456	2.484
" (calculated)	‡	2.447	2.464	2.496	2.488	2.450	2.486

‡ used as parent glass

TABLE NO. IV.: COMPRESSION STRENGTH (According to Gehlhoff and Thomas)

Oxide	Parent Glass	0-5%	5-10%	10-15%	15-20%	20-25%	25-30%	30-35%
Na_2O	80 SiO_2 : 20 PbO	—	—	—1.6	—2.2	—2.6	—	—
K_2O	" "	—	—	—	—2.4	—	—	—
MgO	82 SiO_2 : 18 Na_2O	Very Small						
CaO	" "	—2.0	—0.8	—0.2	—	—	—	—
ZnO	" "	Very Small						
BaO	" "	—1.4	—0.8	—0.5	—0.3	—0.3	—	—
PbO	" "	—2.0	—1.1	—0.4	—0.3	—0.2	—	—
B_2O_3	" "	0	0	—0.5	—0.7	—0.8	—	—
Al_2O_3	" "	+0.25	+0.25	+0.25	—	—	—	—
Fe_2O_3	" "	—0.5	—0.6	—0.8	—1.4	—	—	—

TABLE V.: SCRATCH HARDNESS (According to Gelhoff and Thomas)

Oxide	Parent Glass	0-5%	5-10%	10-15%	15-20%	20-25%	25-30%	30-35%
Na_2O	80 SiO_2 : 20 PbO	—	—	—5	—5	—5	—	—
K_2O	" "	—	—	—4	—	—	—	—
MgO	82 SiO_2 : 18 Na_2O	+5	+4.6	+3.8	—	—	—	—
CaO	" "	+2.4	+3.6	+8.6	—	—	—	—
ZnO	" "	+4.6	+4.4	+4.0	+3.8	+0.3	+0.3	—
BaO	" "	+4.2	+3.2	+2.6	+2.0	+1.4	—	—
PbO	" "	—0.3	—0.3	—0.3	—0.3	—0.3	—0.3	—0.3
B_2O_3	" "	+15	+7	—4.8	—7.6	—9.0	—9.0	—
Al_2O_3	" "	+2	+2.7	+3.6	—	—	—	—
Fe_2O_3	" "	+4.8	+1.0	0	—	—	—	—

TABLE NO. VI.: TENSILE STRENGTH (According to Gehlhoff and Thomas)

Oxide	Parent Glass	0-5%	5-10%	10-15%	15-20%	20-25%	25-30%	30-35%
Na_2O	80 SiO_2 : 20 PbO	—	—	+0.01	+0.02	+0.04	+0.06	—
K_2O	" "	—	—	—	+0.05	+0.07	—	—
MgO	82 SiO_2 : 18 Na_2O	Influence very slight						
CaO	" "	+0.28	+0.2	+0.12	+0.05	—	—	—
ZnO	" "	Influence very slight						
BaO	" "	+0.17	+0.14	+0.12	+0.11	+0.04	—0.08	—0.14
PbO	" "	+0.09	+0.09	+0.08	+0.06	+0.05	+0.04	—
B_2O_3	" "	+0.19	+0.13	—0.05	—0.06	—0.14	—0.14	—
Al_2O_3	" "	+0.16	+0.05	+0.03	—	—	—	—
Fe_2O_3	" "	Influence very slight						

TABLE NO. VII.: YOUNG'S MODULUS OF ELASTICITY (According to Gehlhoff and Thomas)

Oxide	Parent Glass	0-5%	5-10%	10-15%	15-20%	20-25%	25-30%	30-35%
Na_2O	80 SiO_2 : 20 PbO	—	—	— 60	— 40	— 25	— 15	—
K_2O	" "	—	—	—	—130	— 80	— 35	—10
MgO	82 SiO_2 : 18 Na_2O	+110	+110	+110	+110	—	—	—
CaO	" "	+257	+257	+257	+257	—	—	—
ZnO	" "	+ 65	+ 60	+ 50	+ 25	0	0	—
BaO	" "	+110	+ 50	+ 35	0	0	0	—
PbO	" "	+ 50	+ 20	+ 10	0	—	—	—
B_2O_3	" "	+300	+180	+110	—100	—360	—360	—
Al_2O_3	" "	+120	+ 30	0	—	—	—	—
Fe_2O_3	" "	+ 48	+ 48	+ 48	+ 48	+ 48	+ 48	+ 48

TABLE NO. VIII.: BENDING STRENGTH (According to Gehlhoff and Thomas)

Oxide	Parent Glass	0-5%	5-10%	10-15%	15-20%	20-25%	25-30%	30-35%
Na_2O_3	80 SiO_2 : 20 PbO	—	—	+0.018	+0.036	+0.060	+0.10	—
K_2O	" "	—	—	—	+0.023	+0.44	+0.076	+0.104
MgO	82 SiO_2 : 18 Na_2O	+0.024	+0.014	+0.006	0	—	—	—
CaO	" "	+0.080	+0.060	+0.024	—0.05?	—0.026	—0.026	—
ZnO	" "	+0.040	+0.020	0	—0.016	—	—	—
BaO	" "	+0.060	+0.046	+0.024	0	—0.004	—0.018	—0.038
PbO	" "	+0.046	+0.036	+0.026	+0.006	—0.005	—0.016	—
B_2O_3	" "	+0.025	+0.020	+0.014	0	—0.020	—0.020	—
Al_2O_3	" "	—0.018	—0.014	—0.014	—	—	—	—
Fe_2O_3	" "	+0.011	+0.011	+0.011	—	—	—	—

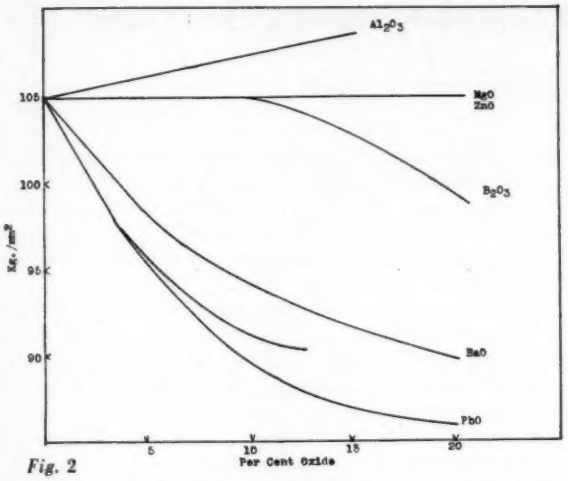

Fig. 2

sented in two ways; the original tables as given by Gehlhoff and Thomas; and as curves calculated from glasses resulting from the substitution of the silica by the various glass forming oxides. In all of the curves the value for zero per cent oxide represents the measured value of the parent 82 per cent silica—18 per cent soda glass.

Table IV gives the specific effect data of the various oxides on the compressive strength of glass, and the curves resulting from the substitution of the various oxides for the silica are given in Fig. 2. While the compressive strength of glass is a comparatively unimportant physical property, inasmuch as glass always breaks in tension rather than compression, the curves show that of all the oxides, alumina is the only one that increases the compressive strength; magnesia and zinc having no effect, while the other oxides cause a decrease.

As the presence of flaws such as scratches and similar imperfections on the surface of glass reduce its practical strength, a glass which has a high scratch hardness will be less liable to break than one having a lower scratch hardness. Marking of the glass surface through abrasion will also be less and the surface will keep a good appearance. This is therefore a fairly important property. The specific effect of the various oxides on this property is given in Fig. 3. From the curves it can be seen that small amounts of boric oxide have great effect on increasing the surface hardness, while lead materially decreases it. The other oxides are grouped fairly close together and the differences are very slight.

As breakage is always caused by tension, tensile strength is one of the most important of the mechanical properties. The specific effect data are given in Table VI, while Fig. 4 shows the curves obtained by calculation of the change in tensile strength of the parent glass when the various oxides replace silica. Lime has the greatest increasing effect followed by B_2O_3, BaO and Al_2O_3.

In window glass the modulus of elasticity of the glass is an important mechanical property, as the lower the modulus of elasticity the more the glass can be bent without breaking. Table VII gives the specific effect data for this property and Fig. 5 shows the curves obtained from the value of the parent glass after calculating the effect of each oxide. It will be seen that lead and alumina have the effect of keeping the modulus low, while lime increases it to a great extent.

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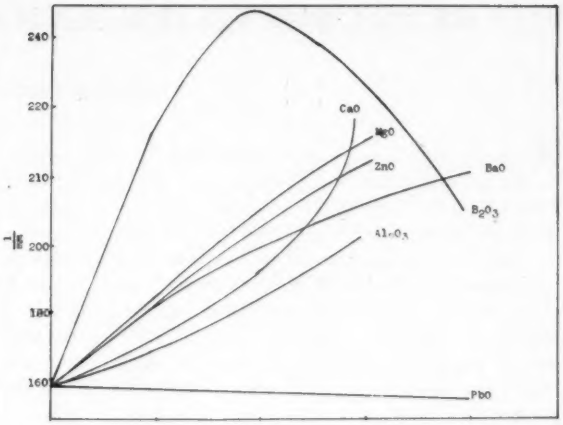


Fig. 3

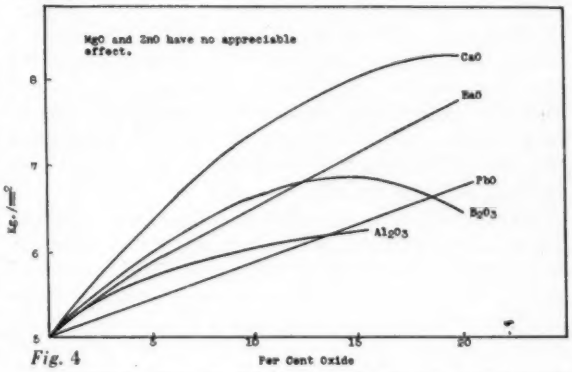


Fig. 4

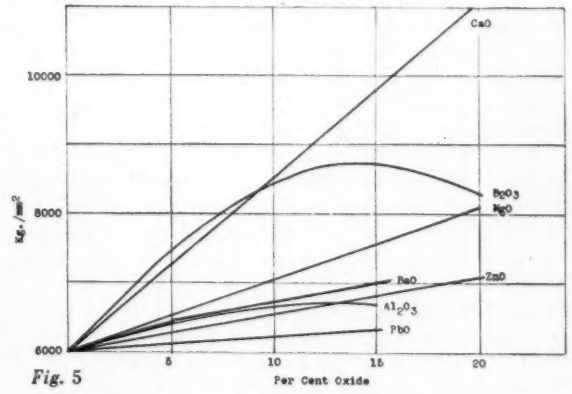


Fig. 5

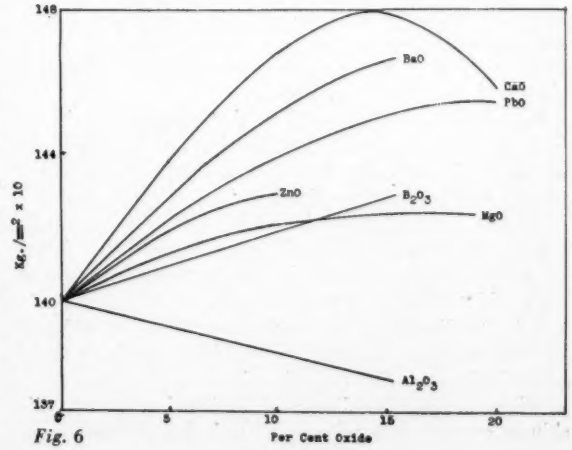


Fig. 6

GLASS DUCTILITY AND PARISON DISTRIBUTION

By GEORGE ROESSLER

That the ductility of melted glass is a function related to the temperature of the glass is a well-known fact. Controlled ductility, by means of controlled temperature, is progressively receiving more and more attention in the practice of making glassware. A review of the practical usefulness of ductility from the simple applications of early manufacture to the more recent method for drawing sheet glass would indicate that ductility provides a precise asset with which glass men are familiar, by and large, but which they do not consciously apply for its greater usefulness.

It is the intention, in this monograph, to outline a theory for obtaining a controlled distribution of glass in the blank mold, at the time of the blow-back, by a certain use of the ductility factor. In this discussion the theory applies to blow-blow methods such as Lynch, Hartford Individual Section, etc. It must be understood, however, that ductility is the characteristic of melted glass which supplies the means by which all processes, blown or pressed, are made effective.

By "ductility" is meant that peculiar characteristic of molten glass by which it stretches, bends and otherwise lends itself to the taking of impressions of the cavity of the mold. The ability of the glass to acquire a shape is related to, and dependent upon, the ductility of the glassy material. Conversely, the ability of the glass to retain its shape after it has been formed is related to, and dependent upon, the lack of this ductility. Therefore, the specific and ultimate functions of the mold are, first, to provide a cavity which is precise for size, shape and figurements, and second, to remove the ductility from the hot glass by lowering the temperature.

Ductility, a technical term, has been traditionally known in the practical field as the "nature of the glass." There are a great many glass compositions and each has its peculiar characteristics. Some glass is extremely liquid at elevated temperatures and its nature is to be quick-setting and at somewhat higher temperatures; thus the ductility, about which this discussion is concerned, is ready or easy only at the above-mentioned temperatures. Other glass is very tough, particularly at working temperatures, and is very malleable or ductile. Some coloring materials affect the nature of the glass, as will also certain impurities when present. However, in the final analysis, ductility and temperature, as related to glass, are inseparable functions.

Now it is a well-known fact that distribution in the finished ware requires a compensating distribution in the blank. This blank distribution has always been a factor which has been determined primarily by empirical methods. Successful blank molds are now being made, but any ideas which will aid in designing better blank equipment will, no doubt, be received by the trade as items of interest and practical worth.

Prior to discussing the practical application of ductility as related to the design of blank molds, a brief resumé of a new theory will be given.

When molten glass is placed against iron a very thin skin or enamel of less ductile glass is formed next to the iron and on the outside of the glass. This enamel has not been changed chemically and is not different from the parent body of glass except that its temperature has been lowered and its ductility changed. It can be identified, practically, as an enamel only because it is less ductile than the rest of the glass.

Now the iron has a high conductivity or great ability to transmit heat from one point to another, and the glass has a low conductivity; therefore, the iron very rapidly absorbs heat at the surface, while the glass is reluctant in replenishing these losses, with the result that a skin is produced which has a lower temperature. All of this follows the first law of thermodynamics; i.e., that heat flows from a body of high temperature to one of low temperature and, when given sufficient time, their temperatures will be equalized. This is the basic, and seemingly well-founded theory underlying all ductility considerations.

If the iron is cold, or better, if the temperature differential between the iron and the glass is pronounced, then the skin will be thick and can be appropriately called a wall of glass. Again, if the gob is retained in its position against the iron for a longer interval of time, the same condition will ensue through creation of an equivalent time-temperature cycle. In each instance the basic phenomenon has taken place in the same manner except to a greater depth. For convenience this will be called "penetration of temperature reduction" or "penetration." The wall of glass caused by this penetration can be identified by its lower ductility.

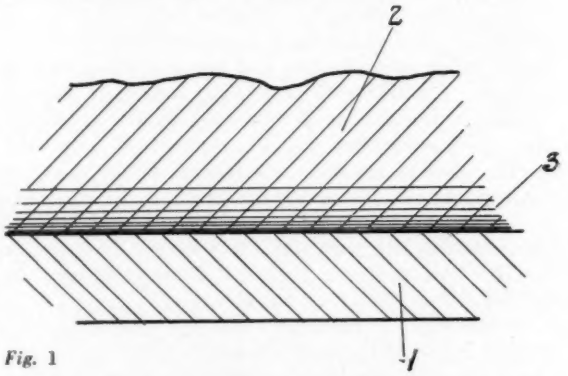
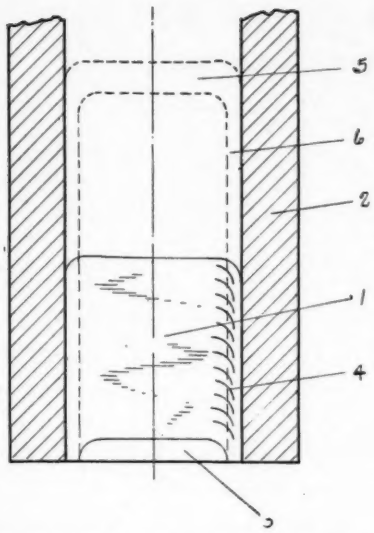
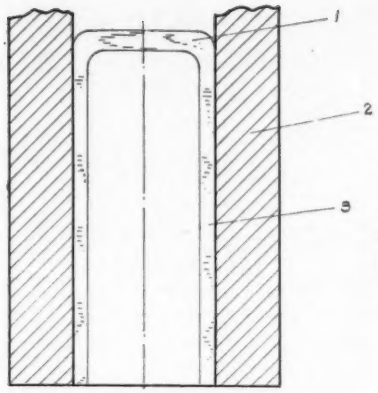


Fig. 1

All of the above theory is illustrated in Fig. 1. The iron is represented at 1; the body of glass at 2. The lines, 3, adjacent to the iron, are much closer together than those more remote from the surface, thus indicating the retrogressive manner in which the ductility is governed by the "penetration of temperature reduction" factor.

Refer now to Fig. 2. This illustrates the forcing of a gob of hot glass along the length of a cylinder. The parent gob of hot glass is shown at 1, the cylinder at 2, and the air bubble, of which the method of creation is of no importance here, at 3. At 4 are "stream" lines which indicate the flow of the glass; or more correctly, the drag of the glass when it is forced upward. At 5 is shown





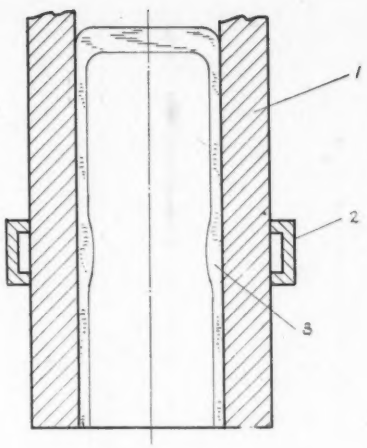


Fig. 2, Left
Fig. 3, Above
Fig. 4, Right

the gob of glass after it has advanced somewhat and, at 6, the wall of glass which is left to harden.

A study of Fig. 2 shows that a gob of glass is dropped into the iron cylinder and is forced in an upward direction by compressed air as indicated by the cavity, 3. The instant the glass meets the iron the penetration begins, thus reducing the temperature and so the ductility of the outer layer of glass, and making this outer layer practically immovable while the inner area of the gob is still relatively ductile. The air, following the path of least resistance, moves the inner mass of glass, while the outer wall remains practically stationary. As the parent body of glass moves upward the temperature of the skin is further reduced and becomes set and rigid. Now all of the area within the wall of penetration is of even temperature because there is no means by which the heat may be dissipated except through the wall. Consequently, the inner area is of even ductility and will advance upward as a body. It is obvious that the center of the gob will not be imperforated by a slender bubble, but the entire inner area will move like a piston.

All of the above teaches the simplest application of the penetration theory as utilized to obtain a hollow, three-dimensional form. There are many variations in the application of penetration of temperature reduction and these, in turn, serve to disclose controllability. Some of these variations will be illustrated in order that a broader background will be laid for the practice as a whole and for the practical usefulness of the theory in the design of molds particularly.

In Fig. 3 a heavy wall of iron is shown and illustrates how the glass will be thicker because the penetration will be deeper. At 1 is shown the glass. At 2 is shown the iron cylinder having a relatively thick wall, which will absorb a greater amount of heat than a thin one, or as known in the art of glassmaking, will "run cold." The thickness of glass as a result of the greater penetration and the consequent reduced ductility of thicker layer of glass is shown at 3.

Turning to Fig. 4 a cylinder of iron is shown at 1. At 2 is shown a cooling element with suitable means for circulating water so as to keep the adjacent part of the cylinder at a reduced temperature. The glass, 3, is thicker at the part of the cylinder nearest the water course because penetration is deeper, correspondingly reducing the ductility of the glass as it moves upward. Above and below the cooling element the penetration will taper nominally as shown. A water course cooling device is shown here, but any recognized means may be employed. Fig. 5 illustrates another application of a cooling element. The glass will be thickened, as shown at 1, for the same reasons as set forth regarding Fig. 4.

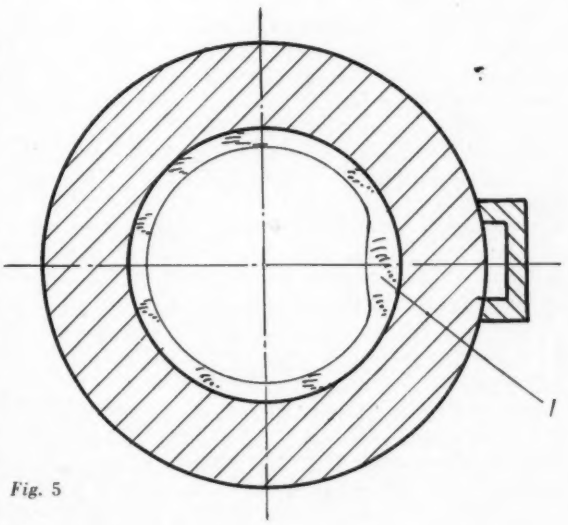


Fig. 5

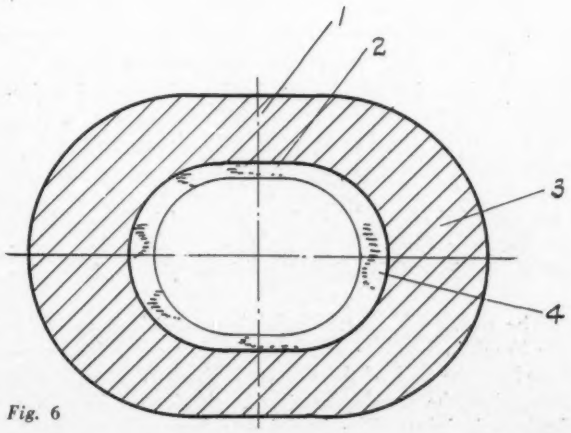


Fig. 6

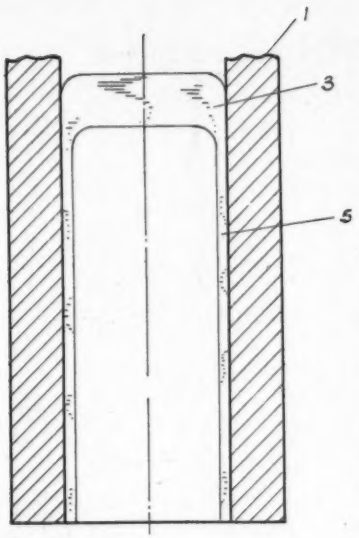
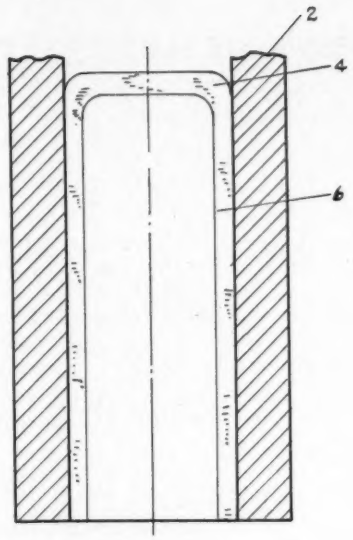


Fig. 7.



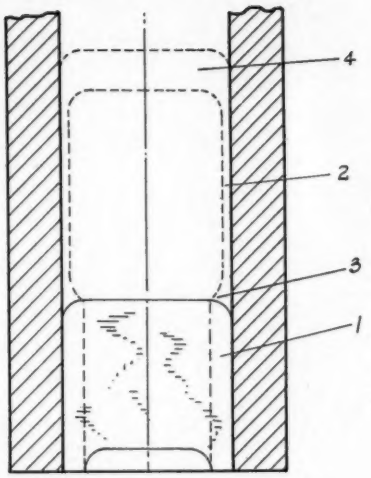


Fig. 8.

A cavity having an elliptic cross-sectional shape is shown in Fig. 6. Note that the iron is relatively thin at 1, and the glass wall at 2; the iron is heavy at 3, and the glass wall at 4. This pertains somewhat to the principle of penetration as it may be applied to blank mold design, of which more will be said in another section of this paper.

The preceding discussion has set forth the principle of penetration as governed by the factor of control of the intensity of heat absorbing qualities of the iron. As has been mentioned heretofore, there is another variation in the controllability of the penetration factor; the regulation of the time cycle during which the glass remains in contact with the iron. The following will make clear this variation of the principle.

The simplest form of "duration of penetration" is illustrated in Fig. 7. Iron cylinders 1 and 2 are alike in every respect. The glass, 3, is forced in an upwardly direction and at a velocity substantially greater than the glass 4, therefore, the thickness at 5 will be much less than at 6 because the duration of penetration is less at 5 than at 6.

Fig. 8 is another illustration of the theory which is very closely related to a practical problem in mold design. The designing problem will be presented in more detail in another part of the paper. The glass wall, 1, is thick because the gob was permitted to lie at rest for an interval of time before it was forced upward. Then it was blown upward at a speed which made a thin wall, as shown at 2. The result is an abrupt break or high-water mark between the two stations of the blowing action as shown at 3. At 4 is the overage of glass which should have been distributed over the section 2, thus illustrating a practical application of the principle of duration of penetration.

All of the above teaches that melted glass, when applied to a blank mold, moves and otherwise behaves in accordance with its ductility; that ductility is a definite function of temperature; and that temperature regulation can be obtained by control of penetration and that this, in turn, is attained by a regulation of the power of penetration and the duration of penetration. Thus is laid the elemental foundation for a principle of glassworking practice which is scientific and exact. Such a principle will make use of the conductivity of iron and glass at varying temperatures, thermal gradients, insulation and radiation, heat dissipation and diffusion, convection, etc. Some of these phenomena have yet to be determined in the laboratory. However, the principles as outlined can be scientifically determined and plotted graphically, correlated and the resultants used as a basis for scientific mold design. A thorough understanding of the ductility theory is essential in acquiring a working knowledge of the behavior of molten glass in blank molds. Distribution in blown ware depends upon a relative distribution in blank molds.

FRANKLIN HONORS DR. HOSTETTER

"In consideration of the combination of technical understanding and executive ability which has enabled him to direct the application of glass to such diversified new uses as a 200 inch telescope disc and saucepans that can be used above an open flame," was the citation that announced the awarding of the Howard N. Potts Medal to Dr. John Clyde Hostetter, Vice President in Charge of Research and Development of the Hartford Empire Company.

The Howard N. Potts Medal is awarded annually by the Franklin Institute of Pennsylvania from a fund provided by the will of the deceased director. It officially recognizes the development or utilization of important basic principles. The honor was bestowed on Medal Day, May 19, concurrent with the presentation of medals to other distinguished scientists.

COMING EVENTS

The annual autumn meeting of the Glass Division of the American Ceramac Society will be held at State College, Pa., on September 10-11.

The Refractories Division will hold its fall meeting September 3-4, at Bedford Springs, Pa.

Committee C-14 on Glass and Glass Products will meet at the Waldorf-Astoria Hotel, New York, on June 30, concurrently with the American Society of Testing Materials. This committee is under the chairmanship of Dr. G. W. Morey.

GLASS MELTS FROM ALKALI-LIME-MAGNESIA-ALUMINA-BORIC OXIDE-SILICA MIXTURES*

By C. W. PARMELEE, A. E. BADGER and W. S. DEBENHAM

In commercial glasses, alumina is present usually in amounts of 2—4 per cent, the effects of such alumina on the properties of glass having been summarized by Ferguson[1] and others.[2] Large amounts of alumina in commercial glasses are exceptional, although an extensive field of high-alumina glasses was shown to exist by the experiments of Berger[3] in his study of the properties of alkali-lime-alumina-silica glasses.

The following account considers some of the glass melts which result when mixtures of the alkalies, calcia, magnesia, alumina, boric oxide, and silica are heated to a temperature of 1450°C. Preliminary data on the determination of resistance to thermal shock are given.

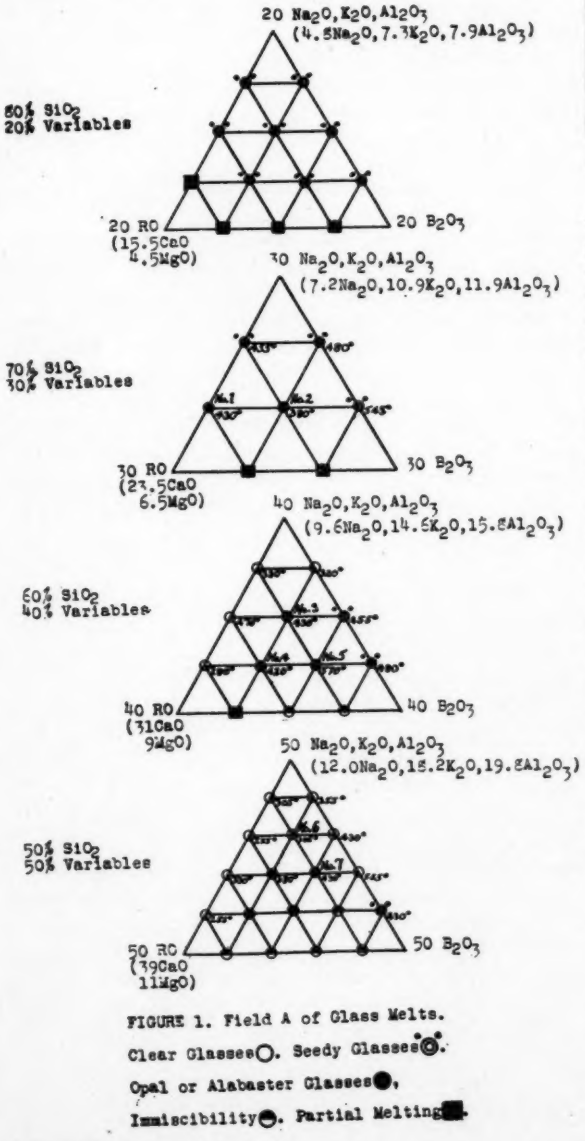


FIGURE 1. Field A of Glass Melts.

Clear Glasses○. Seedy Glasses◉.

Opal or Alabaster Glasses●.

Immiscibility◓. Partial Melting■.

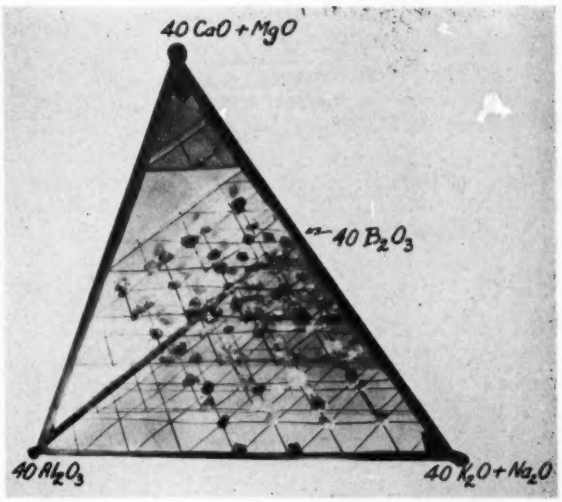


Fig. 2

Preparation of Glasses: Each glass batch weighed about one pound, the silica being introduced as finely ground quartz sand, Na_2O as Na_2CO_3 and $NaNO_3$ (equimolal proportions); K_2O as K_2CO_3; CaO as $CaCO_3$; while MgO, B_2O_3, and Al_2O_3 were introduced as such. All of these materials were of the technical grade of purity.

The glass batches were mixed thoroughly and placed in fire-clay pots which were set in saggers in a gas-fired test kiln and heated at 1450°C for four hours. The gas was then shut off and the kiln allowed to cool at its natural rate down to 600°C. A slower cooling rate was used from 600 to 400°C, and the natural furnace cooling rate from 400°C to room temperature. This slow cooling schedule aided in the development of the opacity of some of the glasses.

Glass Compositions—Field A: Field A consisted of 49 glass compositions containing 50, 60, 70, or 80 per cent SiO_2. The lime and magnesia were added in the weight relationship of seven parts CaO to two parts MgO, this ratio being fixed quite arbitrarily, although in some glasses it has been found to be beneficial.[4] The alkalies and alumina were added in the molecular proportions, 1 Na_2O : 1 K_2O : 2 Al_2O_3. This equimolal relationship between alkali and alumina is found in feldspars and consequently the feldspars can be used as the source of alkalies and alumina in these glasses, no free alkali as soda, potash, etc., being necessary.

The results of the experimental meltings in Field A are shown in Fig. 1, which indicates that with 80 per

* Published with permission of the Engineering Experiment Station, University of Illinois.

[1] Ferguson, R. F.; Cer. Ind. 22, 362 (1934).

[2] See, for example, the pamphlet, "Feldspar as a Constituent of Glass," prepared by the Bailey & Sharp Co. (Hamburg, N. Y., 1937).

[3] Berger, E.: Glastech. Ber. 5, 569 (1928).

[4] Dimbleby, V., Hodkin, F. W., Turner, W. E. S.: J. Soc. Glass Tech., Trans. 5, 352 (1921).

[5] It is a pleasure to acknowledge the aid of L. G. Goldberg and B. C. Viger in making the tests on resistance to thermal shock.

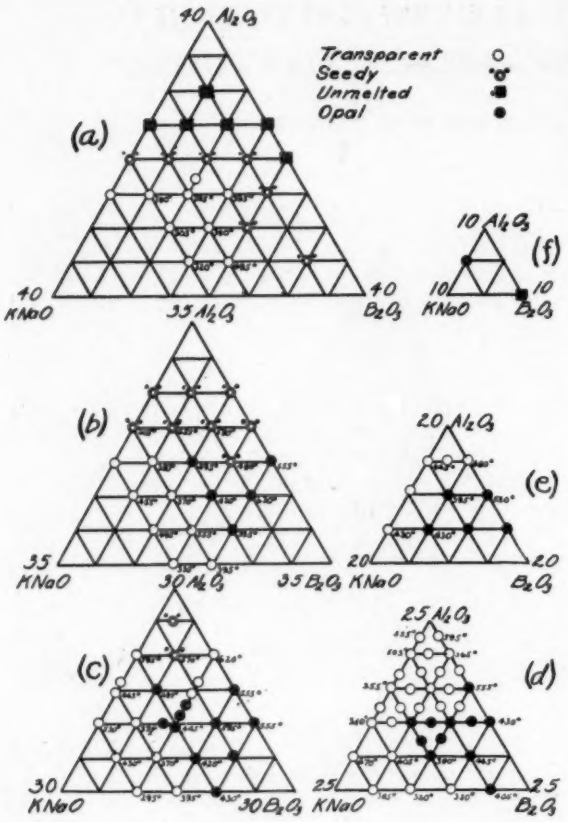


Fig. 3

cent SiO_2 no homogeneous glasses were formed, all melts being white and seedy or only partially melted. In the field containing 70 per cent SiO_2, Glasses Nos. 1 and 2 were alabaster, the others being seedy or unmelted. The field containing 60 per cent SiO_2 produced a number of good glasses, including a fine opal (No. 3) and two alabasters (No. 4 and No. 5). The field with 50 per cent SiO_2 produced the greatest number of clear glasses, as would be expected from the greater flux content. Glass No. 6 showed a faint opalescence; Glass No. 7 was a fine opal. An extensive field of immiscibility existed when the content of alkali and alumina was low.

The significance of the temperature readings in Fig. 1 is stated below in the section on the thermal shock characteristics of the glasses.

Glass Compositions—Field B: Field B of glass compositions consisted of 106 glasses in which the silica was maintained constant at 60 per cent, the variables being the alkalies, calcia, magnesia, alumina, and boric oxide. Of these variables, the alkalies existed in an equimolal relation, while calcia and magnesia were in the proportion by weight of seven parts CaO to two parts MgO. The alumina was added in varying amounts, the fixed proportion of alkali to alumina which was used in Field A being discarded.

After the melting process, a fragment of each test was mounted on a tetrahedral space model (Fig. 2), each apex of which represented 40 per cent of the variable constituents, as alkali, alumina, boric oxide, or RO.

Figs. 3a, b, c, d, e, and f show the type of glasses produced on different planes of constant lime-magnesia value, as taken from the space model shown in Fig. 2. The largest diagram (Fig. 3a) forms the base of the tetrahedron and is, therefore, totally lacking in lime and magnesia. As the planes decrease in size, the lime-magnesia content increases from zero to a maximum of 30 per cent. All these melts contained 60 per cent silica.

Considering the planes in order, it is seen that with no lime or magnesia present (Fig. 3a), an unmelted area appears with more than 20 per cent alumina. Glasses containing 20 per cent alumina were all seedy, increasing in opacity as the boric oxide increased and the alkalies decreased. All glasses with 15 per cent or more alkali and less than 20 per cent alumina were clear.

In the next plane (Fig. 3b) with five per cent lime-magnesia, it was found that, although none was unmelted, all glasses with 20 per cent or more Al_2O_3 were seedy. Opal and alabaster glasses appeared in this field, passing from opalescent with 15 per cent Al_2O_3 + 10 per cent B_2O_3 to white with five per cent Al_2O_3 and 20 per cent B_2O_3. Clear glasses resulted with 15 per cent or more alkali content.

In the 10 per cent lime-magnesia plane (Fig. 3c), a seedy glass is shown on the 20 per cent Al_2O_3 line, containing five per cent each of B_2O_3 and of alkali. The opalescent area was considerably increased, the melts within the area bounded by the 10 per cent alkali line and the 15 per cent Al_2O_3 line showing this characteristic. The remaining glasses were clear.

With 15 per cent lime-magnesia (Fig. 3d), seedy glasses were eliminated and the clear glass area considerably extended. The opalescent glass field was bounded roughly by the 10 per cent Al_2O_3 line and the 10 per cent alkali line.

The 20 per cent RO plane (Fig. 3e) showed clear glasses when the Al_2O_3 was 15 per cent or more and also when B_2O_3 was absent. Otherwise opalescent glasses were the rule.

Only two melts were made in the last plane containing 30 per cent lime-magnesia (Fig. 3f). One containing 10 per cent B_2O_3 was unmelted, while an opalescent glass was produced with five per cent each of Al_2O_3 and of alkali.

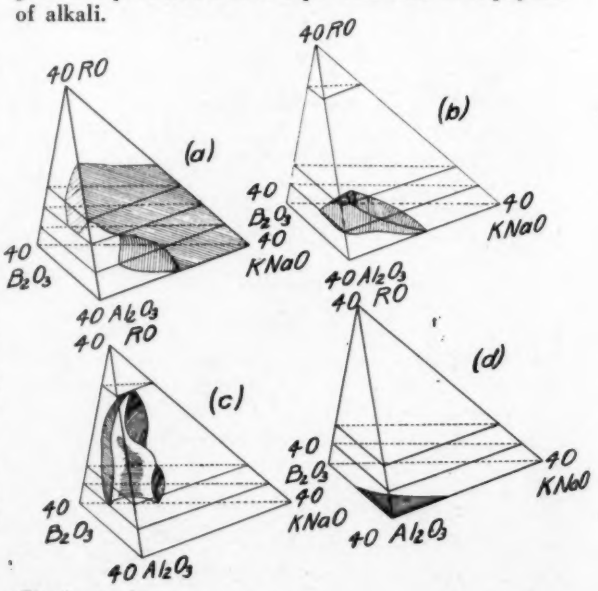


Fig. 4

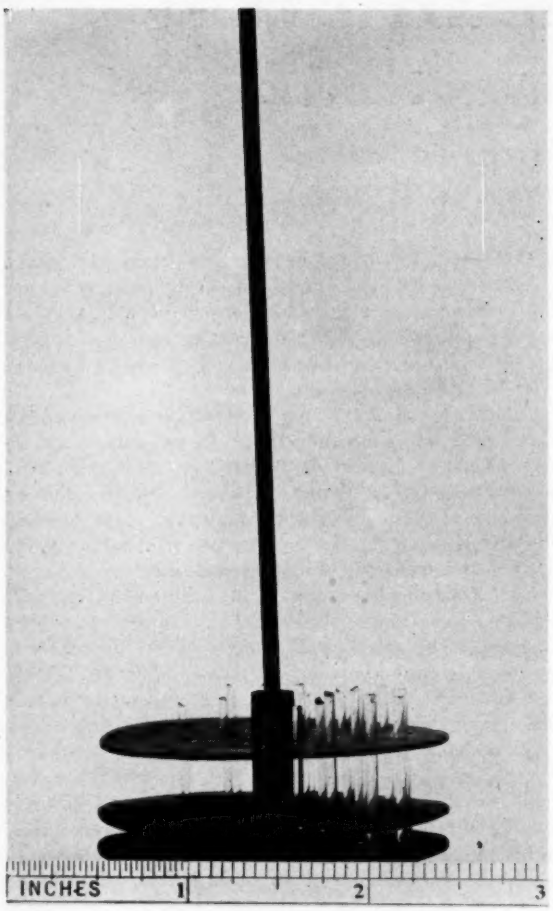


Fig. 5

In order that a clearer picture might be obtained of the areas containing the different types of glasses, space diagrams of the various regions are shown in Fig. 4a which represents clear glasses, 4b of seedy glasses, 4c of opal or alabaster glasses, and 4d of partial melts.

Determination of Resistance to Thermal Shock of Glasses: The resistance to thermal shock[5] of the glasses was determined in a comparative manner with the device illustrated in Fig. 5. The glass samples were drawn out into rods two cm. long and with a diameter of 1.35 mm. $\pm$0.05 mm. Many of the opal glasses became clear after this treatment. The drawn glass rods were not annealed and so the tests compare glasses possessing some internal strains. The glass rods were placed in the holder (Fig. 5) which was heated in an electric furnace. At definite temperatures, the holder containing the samples was removed from the furnace and quenched quickly in water at 20°C, after which any breakage was observed. By raising the furnace temperature in small steps, the maximum temperature change which the glasses could stand without breaking was determined. This temperature difference was taken as a comparative measure of the resistance to thermal shock of the glasses. These temperature readings are given in Figs. 1 and 3. Reference to these figures shows that glasses resistant to thermal shock were the high-alumina low-alkali glasses. The best thermally resistant glasses were those containing high alumina together with notable amounts of boric oxide.

MIRRORS FROM PHOTO PLATES

Is your pocket mirror thick or thin? If it is thick, just feel the edges beneath the strips of paper or cloth pasted over them. If you find two edges instead of one, you can be sure that your mirror is made from a pair of used Japanese photo plates. It's a new Japanese industry, this photo-mirror making, and the first year's returns (1936) are estimated at well over Yen 300,000 (approx. $84,000).

Such mirrors are not necessarily to be despised. They are often better than the ordinary kind, especially the cheap ones. For it goes without saying that photographic plates are made from meticulously selected materials. However good the emulsion cast, or the negative pictures recorded on them, they become useless after some years of storing in the photographers' filing cabinet, and can be obtained at extremely low cost. The only disadvantage pertaining to the use of photographic plates is that they are not, as a rule, thicker than 0.9 mm. Therefore, in order to obtain the desired thickness, two plates, or even three, are placed together when mirrors for women are to be manufactured.

Japan being the world's largest consumer of photographic plates, there is an ample supply of negatives which have served their purpose. Yet imports of scrap plates will have to be resorted to as the photo-mirror industry grows. A by-product of this industry is the manufacture of round glass windows for typewriter keys.

COMPLAINT ISSUED AGAINST W.G.M.A.

The Federal Trade Commission issued a complaint on June 16, against the Window Glass Manufacturers Association, the National Glass Distributors Association and several affiliated companies charging a conspiracy to fix and maintain discriminatory prices at an artificial level through control of supply sources and channels of distribution.

WHERE DID THE TEASER GET HIS NAME

The man who fed an old-style furnace with coal, or the one who nowadays shovels batch into the tank and looks after the reversals and the fire, is called a "teaser". Those who look for a logical origin in English for this word are probably disappointed. The man does not vex or irritate the furnace even though he makes it hot. In French, the verb "tiser" means to stoke, and a "tisseur" is a stoker. It seems quite likely that we have borrowed the word along with other inheritances from our European predecessors in glass making.

MODERN GLASS HAS ROMAN PROTOTYPES

The glass collection of the University of Pennsylvania is one of the most interesting in the country. Much of this collection, although made in the East, dates from the period of Roman domination and is commonly known as "Roman" glass.

In this collection are found cinerary urns, jugs, bottles, dishes, goblets, bowls, and tumblers. Every shape that is familiar today has its prototype in the pieces in the Roman collection. Many of these pieces have a beauty of line, which when combined with color, are well worth copying. Oddly enough, the colors, too, are popular today: amethyst, sapphire, amber, and green.

THE ART OF DECORATING GLASS

III: THE SILK SCREEN PROCESS

By V. H. REMINGTON
B. F. Drakenfeld & Co.

• *This article continues the discussion on processes and procedures of glass decoration begun in the April issue of* THE GLASS INDUSTRY. *The first number of the series dealt with the spraying process, the second and present article with the silk screen process.*—THE EDITOR.

The intricate nature of many designs has been responsible for the development of methods of screen stencil preparation other than knife cut screens earlier described.[1] The use of photographic principles has made it possible to produce long wearing screens at low cost and there is little doubt that still greater progress will be made.

The preparation of the photographic screen plate is based on the discovery made many years ago that a colloid, such as glue, gelatin, or gum arabic, containing a bichromate is rendered insoluble in water when exposed to light. Many ways have been devised for making screen plates but the underlying sensitizing principle is the same in all cases.

There are two main photographic methods: direct and gravure. Both are used to a very large extent in the making of screens for ceramic colors though the gravure method undoubtedly produces a sharper print. Sawtooth edges are often characteristic of the direct method, especially with the coarser silks.

The Direct Method

The procedure for preparing a screen by the direct method may be briefly outlined as follows:

1. Stretch silk on frame.
2. Coat silk with bichromated glue or gelatine solution (sensitizing solution).
3. Dry in dark room.
4. Place film or plate, with design drawn on it, in intimate contact with dried screen.
5. Expose to strong light.
6. Wash plate under running water (the unexposed portions will wash out of silk leaving openings through which color may be printed).
7. Dry screen and put in use.

There are a number of sensitizing solutions on the market by means of which an inexperienced operator can quite easily prepare his own photographic plates.

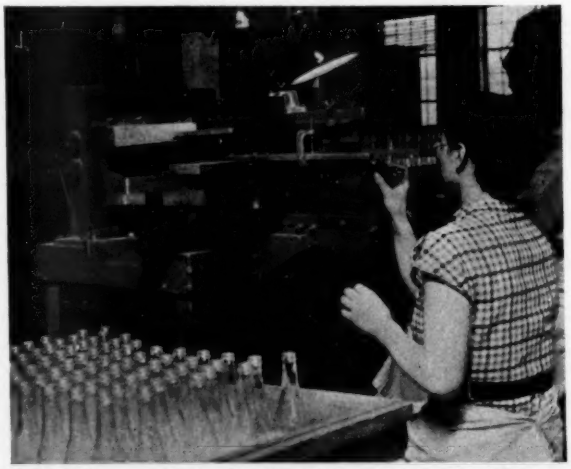
A good sensitizing preparation can be made from the following: 2 quarts hot water, 8 ounces gelatine (finely ground), 1 1/3 ounces potassium bichromate, 1 1/3 ounces ground rock candy. Dissolve the dry ingredients in the hot water and strain. The resulting solution, now ready for use, can be applied to the dry, tightly stretched silk by flowing or by means of a rather wide camel's hair brush. For the smaller screens, the flowing method is best. Hold the screen in an upright position and pour the solution over the face of the screen. The excess solution can be saved and used over again. It will congeal upon cooling but can be made ready for use by heating in a double boiler. It must be kept hot during application. When the coating operation is complete the screen should be dried. This can be hastened with fans or a drying cabinet.

Another good sensitizing formula recommended by Zahn[2] consists of the following: ¾ oz. ammonium bichromate, 1 oz. Nazdar photo glue, 2 oz. Le Page's photo-engravers glue, 10 drops glycerine. Dissolve the bichromate in 4 ounces of warm water and allow to stand for one hour in the dark. Dissolve the Nazdar photo glue in 8 ounces of cold water and soak for about an hour. Pour the first solution into the second and add the photo-engravers glue which previously has been warmed. The resulting mixture plus the glycerine is poured into a double boiler and heated to 200°F. Strain several times and keep in dark room until ready for use. This sensitizing solution must also be applied hot.

In order to more easily see the pinholes which frequently develop in coated screens the sensitizing formula may be dyed. Dissolve one-half ounce of water soluble purple analine in one-half ounce denatured alcohol, then add dye and alcohol to eight ounces of water. Use two ounces of this dye solution instead of two ounces of water in making the sensitizing coating.

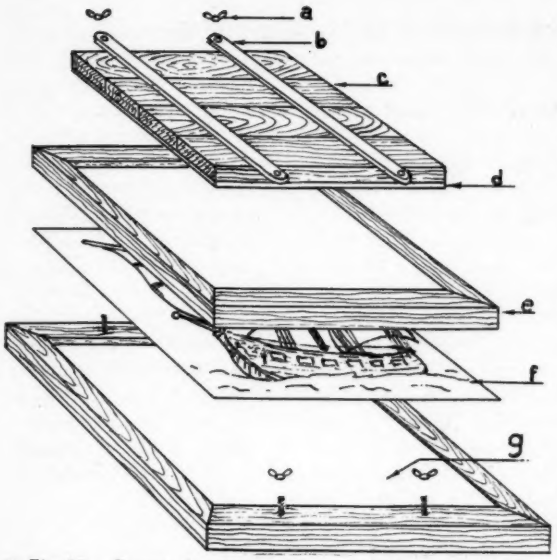
All operations can be carried on with safety under the light from a 40 watt lamp except the drying which must be done in total darkness.

When the drying is complete the screen is ready for exposure. This is best done in a contact frame which can either be made or purchased from one of the screen supply companies. Fig. 11 illustrates the order of assembly. It is important that good contact be made between the negative or positive and the screen.



• *Machine for printing tumblers, beverage ware, etc. The selected ware is placed immediately in the lehr for firing.*

[1] THE GLASS INDUSTRY, June, 1937, page 195.
[2] Bert Zahn "Silk Screen Method of Production," page 81.



● *Fig.* 11. *Contact frame assembly. (a) Wing nut; (b) Hold-down bar; (c) Contact block; (d) Felt covering; (e) Silk screen; (f) Positive; (g) Plate glass.*

The exposure may be made by sunlight, daylight or artificial light. In bright sunlight ten minutes should be sufficient, whereas, on dull days exposure up to one and one-half hours may be required. An exposure of thirty minutes with a carbon arc at 18″ distance is sufficient.

After the exposure has been made wash out the unexposed portions by allowing warm water to pass over both sides of the screen. When this has been done it may be dried as before.

To prevent paint leakage the screen should be taped around the edges. It is also a good policy to give the completed screen a protective coating of blocking-out lacquer. This will add considerably to the life of stencils used on printing machines.

The Gravure Method

The gravure method, better known as the carbon-tissue method, is an adaptation of a photo finishing process to silk screen plate preparation. It reproduces details with fidelity and if properly handled prints made with it will show no saw-tooth effect. The making of carbon tissue screen is a comparatively simple and straightforward process but instructions unfortunately make it appear more involved than it really is.

Carbon tissue is a pigmentized, gelatine-coated, absorbent paper. There are two principal makes: Autotype[3] and Eastman[4]. The handlng of both is about the same.

Equipment—Once provided with the correct positive an extensive outlay of equipment is not necessary to make carbon tissue screens. It is suggested, however, that the following minimum list of materials be made available:

Supply of carbon tissue.
Two trays large enough to accomodate size of tissue used.
One ferrotype plate, approximately 12 x 20 inches.
One polished copper or chrome plate, approximately 12 x 15 inches (a plate glass square can be used if necessary).
A good source of bright light such as a sun lamp or photoflood bulb with reflector.
One ruby lamp or yellow dark room safe light.
Supply of blotters.
Waxing solution.
Negative opaque.
Sheet of mat-finished celluloid for hand-made positives.
Sensitizing solution.
Rubber squeegee blade, 8 to 10 inches long.
Contact printing frame, 10 x 12 inches.

The Carbon Tissue—Carbon tissue was first developed as a photographic printing medium. It was later further developed for transferring a photographic image to a flat copper plate or a copper cylinder, from which printed impressions could be made on either a flat-bed gravure press or a rotogravure press. This same tissue is now being used for making photographic silk screen plates.

The Autotype Company is the oldest maker of carbon tissue and their No. 49 is especially recommended for screen work. Their numbers 94 Ivory Black, 106 Red Chalk, and others may be used. Sheets are available in sizes 5 x 7 inches, 8 x 10 inches, and rolls 2½ x 12 feet. Eastman's photogravure tissue comes in one grade and one color, red. It is supplied only in rolls 3 x 12 feet.

Best results with carbon-tissue are secured from fresh stock, tissue that is not more than 6 or 8 months old, since the gelatin becomes less soluble with age. Carbon tissue very quickly absorbs moisture from very damp air, but it also dries very quickly and becomes brittle if there is no moisture in the air. Consequently, if the pigment paper appears very dry and liable to crack, it should be placed in a damp place for a few hours to get it into a more pliable condition.

The Dark Room—If a number of photographic screen plates are to be made, a room especially provided for this work will be a great convenience. However, such a room is not an absolute necessity since all operations except the drying of the sensitized tissue can be carried on under artificial light.

The Sensitizing Bath—The essential constituent of a carbon tissue sensitizing bath is potassium bichromate. Other agents are often added in order to prevent the screen plate from becoming brittle while in use or storage. Any of the following bath formulae are reliable.

Bath No. 1—Potassium Bichromate 3¼ oz., Water 128 oz.

Bath No. 2—Potassium Bichromate 3¼ oz., Water 128 oz., Ammonia about ¼ oz.

Add ammonia drop by drop until original orange color of solution turns yellow.

Bath No. 3—Potassium Bichromate 2½ oz., Ammonium Bichromate 2½ oz., Magnesium Sulphate (Epsom Salts) 7½ oz., Water 128 oz.

Distilled water should be used in the above if available.

The sensitizing solution should be kept in the dark when not in use, and preferably stored in brown bottles. It may be used several times, but it is a little difficult to determine exactly how long it will remain in working order: more depends on the period elapsing between each time of use than upon the amount of pigment paper passed through it. A solution over a week old can not be relied upon.

Sensitizing the Paper—The carbon-tissue should be immersed in the sensitizing bath until limp. Usually two minutes time is sufficient. Upon removal it can either be hung up or squeegeed face down on a photographer's

[3]Autotype Company of England. Obtainable from Geo. Murphy, Inc., 57 East 9th St., New York City.
[4]Eastman Kodak Company, Rochester, N. Y.

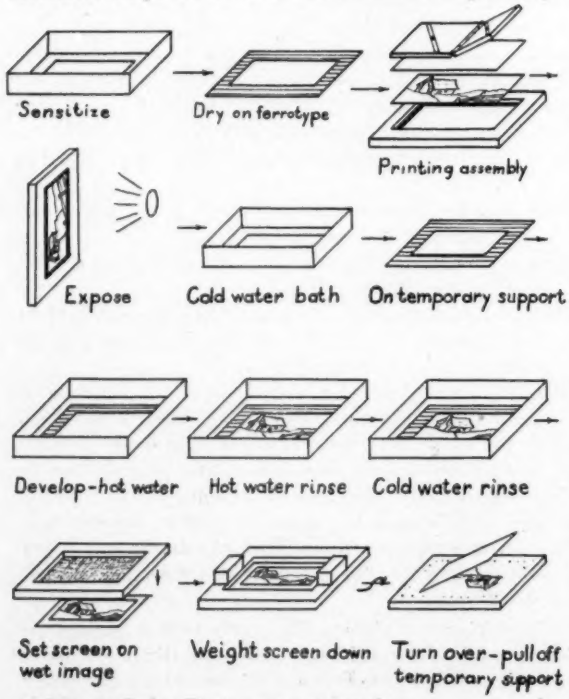
ferrotype plate to dry. The dry paper will release itself from the plate and have a very smooth surface, which will make better contact with the negative (or positive) than paper that has simply been suspended while drying. It is not necessary to use the sensitized paper immediately but if stored it should be kept in a cool, dry place. The temperature of the sensitizing bath should not exceed 55°F. To lower the temperature of the bath set in a tray containing cracked ice.

Printing—Any of the ordinary printing frames will serve one's purpose as long as good contact is made between paper and positive. The dried sensitized tissue is placed over the positive in the frame and clamped down. A point of importance, though, in carbon printing is the provision of a "safe edge." This consists of a narrow opaque margin around the edges of the tissues. The safe edge is necessary to ensure a soluble margin to the pigment paper so that in the course of subsequent development the tissue backing sheet may be easily removed. An opaque mask can either be placed in the frame under the tissue or black masking tape can be placed on the outside of the glass over the edge of the tissue to a width of ¼ - ½ inch.

In making the exposure a good carbon arc sun lamp or several photoflood bulbs may be used. Length of exposure depends upon light intensity and distance of tissue from it. Usually two to six minutes time will be found sufficient. To determine the proper time, one should make an exposure test by placing a sheet of tissue behind a positive in the usual manner. Now make four exposures as follows:

Expose entire design for 2 minutes
Cover ¾ of design and expose for 2 minutes.
Cover ½ of design and expose for 2 minutes.
Cover ¼ of design and expose for 2 minutes.

By this means the tissue will have been exposed in four successive strips for 2, 4, 6, and 8 minutes respectively.



● *Steps in Carbon-Tissue screen preparation.*

When developed, as later described, that portion of the design which washes out the cleanest and adheres best to the silk will serve to indicate the optimum exposure time. More than 8 minutes may be required. In that event make a new series but make the initial exposure 10 minutes instead of 2 minutes. Over exposure tends to cause the gelatine to separate during development.

Cold Water Bath—After exposure the pigment paper is immersed in cold water until limp and then laid, gelatin side down, on the temporary support. A flat squeegee is passed firmly over the back several times, from the center towards the edges, to remove air and moisture.

The Temporary Support—The purpose of the temporary support is to hold the exposed gelatine sheet during the course of development and while being attached to the silk. A plate glass square or a polished copper or chrome plate can be used. After being thoroughly cleaned and polished a coating of rather high melting wax should be evenly applied and polished. Autotype special waxing compound dissolved in naphtha is recommended though a very good one can be made by dissolving one-quarter ounce resin and one-half ounce beeswax in one-half pint turpentine. The temporary support should not be used for at least an hour after waxing.

Development—The development of the tissue is done in clean hot water and in ordinary daylight. The mounted tissue is immersed in hot water the temperature of which is approximately 100°F. After a short period the soluble parts of the pigment paper will begin to ooze out at the edges. When this occurs one may then remove the backing sheet which once held the gelatine. Carefully raise one corner and strip away. The separation should take place under water.

Gradually wash away the remaining soluble pigmented gelatine by rocking back and forth. When the design has been completely etched rinse in a second hot water bath, chill for a moment in cold water and mount on screen.

Mounting Film on Screen—To attach the film to the silk, first place the chilled support, film side up, on the table. Next, carefully set the screens on it and squeegee into contact, removing excess moisture with blotters. After allowing it to dry, cautiously pull screen away from temporary support. The open areas around the edge of the film can be taped up or filled with screen filler.

Preparation of Positive—If the design to be reproduced is drawn in black on a white background a positive must be prepared. This is done by photographing the design and from the negative preparing a positive, usually by projection. The work can be done by any photographer if the decorating shop is not equipped with photographic facilities.

One can, also, make their own positives by drawing the design on matt finished celluloid using an opaque ink or paint such as negative opaque.

Gelatin Sheet Method

The use of sheet gelatin is the foundation for one of the best methods of making photographic silk screen plates. This gelatin is sold in sheets measuring approximately 20 x 24 inches and though it may be had in many colors daylight or royal blue are recommended as best. It is used mainly for theatrical stage lighting purposes and may be secured from any theatrical supply house. Do not attempt to use old material.

Attaching Gelatin to Silk—The most difficult problem

in using gelatin sheet is that of attaching it to the silk. Some workers favor temporary supports but when these are used it will be found that the gelatin not only swells too much in development but can not be made to adhere well to the screen.

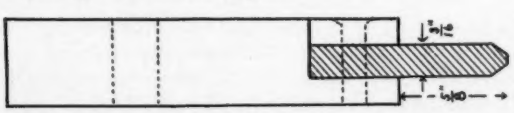
Very good results have been achieved by pressing the dampened gelatin sheet into the silk. To do this requires a press; an old letter or book press will serve admirably.

On the bed of the press lay a sheet or two of blotting paper and a light felt blanket. Cover this with cellophane or 0.002 inch clear celluloid with nitrate base. On the celluloid lay the gelatin sheet cut slightly smaller than the inside dimensions of the silk covered screen frame. Thoroughly wet the silk by immersing screen and all in lukewarm water for two or three minutes. Remove, drain briefly and lay on top of the gelatin sheet. Cover the inside of the frame with several sheets of good quality rag paper, paper that does not disintegrate upon wetting. Cover with a felt sheet and on this place a perfectly smooth flat block which should be thick enough to project above the screen frame, likewise, it should be large enough to completely cover the gelatin sheet. Screw the press down snugly and allow to stand for 15 or 20 minutes. Under pressure the dampened gelatin flows into the meshes of the silk and becomes rather firmly attached. Upon removal from the press the cellophane backing can usually be stripped off easily. If not, wait until the assembly is dry. Should it still prove stubborn it can be dissolved off with cotton swabs moistened with acetone.

Sensitizing the Film—To sensitize the film immerse in a sensitizing bath for one-half to one minute, quickly covering the inside and outside of the screen with the solution. Formula No. 3 is recommended but should be used fresh and cooled to 50°F. After sensitizing, the screen is given a cold water rinse and dried in total darkness. Fans may be used if necessary. The drying should be carried to the point at which the gelatin is no longer tacky but it should be stopped before the silk is bone dry since overdrying may render it insoluble and hard to wash out after the exposure.

The Exposure—The sensitized screen plate is exposed by being first clamped in a printing frame as shown in Fig. 11. Expose to either daylight or artificial light. A carbon arc or a Cooper-Hewitt lamp are excellent sources of the latter. Usually 30 to 45 minutes exposure to a good bright northern light or 10 to 15 minutes to strong artificial light will be required. Heating the gelatin during exposure may cause it to become insoluble. For that reason avoid direct sunlight and do not permit the lamp to heat the film.

Development—The development of a gelatin sheet is a comparatively simple operation. Merely hold the plate under running hot water until the unexposed portions are completely washed out. Pay particular attention that the last traces of soluble film are removed from the edges of the design. The development may be done under artificial or subdued daylight. After drying, the edges should be taped up and the screen put in use.



● *Fig.* 12. *Squeegee blade and holder for machine printing.*

Printing the Color

The Squeegee—A rubber known as the squeegee is used for forcing the ceramic color paste through the screen. The rubber should be mounted in a wooden holder or grip shaped to the convenience of the operator. Some of the larger screen process supply houses sell ready made squeegees in lengths up to five or six feet. One needs then only to saw off a length suitable for the job. For the small frames, or for work that is to be printed on any of the machines, the operator must make his own squeegee.

In selecting the rubber for the blade, care must be taken to secure stock that will resist the sofening action of oil and naphtha. It should not be too flexible.

For a manually operated squeegee, say eighteen to twenty-four inches long, one should select rubber one-quarter to three-eighths of an inch in thickness, and wide enough to make a blade about four and a half inches wide. For smaller squeegees, rubber one-eighth to three-sixteenths of an inch in thickness will be found satisfactory. In any case it is important that the working edge be kept sharp. No operator can expect good, clean cut work from a dull blade. Accordingly, when the edge of the squeegee becomes rounded it should be resharpened.

To sharpen the squeegee place two parallel blocks on a sheet of medium grained emery cloth, leaving a space between the blocks only slightly wider than the rubber blade. Then, with the assistance of the blocks to hold it perfectly upright, pull the blade back and forth on the emery cloth, meanwhile exerting a uniform pressure. Only a few strokes should be required to place a sharp edge on the blade. Small blades may be sharpened on an emery wheel. The rubber is brought into contact with the grinding wheel at the correct angle and moved back and forth across it until proper bevel is secured. Both sides should be treated alike. See Fig. 12.

Preparation of Color—The colors to be used in printing are ordinarily supplied by the manufacturer in powder form though the ready-mixed paste may be secured if requested. To prepare a printing paste, the powder should be thoroughly mixed with a suitable oil commonly known as squeegee oil. If only a small amount of color paste is needed at one time the mixing may be done by means of a spatula or a printer's knife on a glass tile. It is not necessary to grind the color; it is sufficient to thoroughly mix it with the oil. However, in all production work a paint mill of the burr type should be used.

Frequently it will be found that these mills will not smooth out and mix the small dried particles of color thoroughly with the oil. When this happens, the mill should be sent to the machine shop, where a good mechanic can quickly reface both grinding surfaces so that the moving burr seats perfectly with the stationary plate.

There are no definite standards as to paste consistency. Some operators prefer a rather stiff mixture, others one as thin as ordinary mixed cold paint.

Ceramic color that is to be used for squeegee work must be kept *bone dry*. This point can not be over emphasized. If the color powder absorbs moisture it will, after being mixed with the oil, lose its fluidity and become stiff and unprintable. Should it be possible even then to print the color after more oil has been added the fired results are quite likely to be dull or entirely matt. Squeegee color powder should be stored in a warm dry

place. Some shops are provided with drying cabinets in which two or three days color supply is kept until ready to be mixed with oil. Others keep the color dry by setting it on the lehr.

If Lipoidol[5], in the proportion of three or four grams to each quart of color is added to a paste mixture that has "set up," its original fluidity can usually be restored.

Printing—During the course of the printing operation the screen is set so that it rests about one-eighth to one-quarter inch above the article being decorated, the distance depending upon the size of screen and amount of "flex" in the silk. In other words, the stencil is brought in contact with the glass only as it is forced there by the squeegee. As it passes over the stencil, the silk rises behind the squeegee thus breaking contact with the glass. A print so made is sharp and has greater body than it would have if the screen rested in contact with the glass.

Usually one even stroke of the squeegee over the stencil is all that should be required and to this end the consistency of the color should be adjusted. If the print appears dry or screen marks are distinctly visible more oil should be added to the color. On the other hand, an excess produces prints which appear weak after firing.

In the case of machines printing round bottles, it is the usual practice to adjust the screen so that it just rests on the bottle. In this position the screen is subjected to a minimum amount of wear. A few colors may print sharper if the screen is placed 1/16 - 1/8 inch above the ware.

Occasionally some difficulty may be experienced in securing good clean cut uniform prints. Moisture in the color, or poorly mixed colors, cold damp ware, bottles with uneven surfaces, and an improperly adjusted squeegee blade are possible causes of trouble.

Drying—If the printing operation consists in the application of only one color it is not necessary to provide for drying of the color before firing it. Usually, in the case of bottles and tumblers, the ware is taken immediately from the printer to the lehr for firing. Printing of signs, however, ordinarily entails multicolor work. In this case each of the applied colors should be allowed to stand over night or else dried in a heated dryer. In the latter case considerable care must be taken that too much of the oil is not expelled; that the drying should be carried only to the point where the color is no longer tacky. The reason for this is that if succeeding colors overlap, screen marks will show up where this happens.

Blistering—Blistering is one of the most common defects of fired ware. It may consist of an occasional bubble in the glaze or a general froth in the entire print. Some of the principle causes of blistering are:

1. Insufficient heat in the preheating zone of the lehr.
2. Use of squeegee oil containing tarry or low boiling constituents.
3. Dirty ware.
4. Use of color contaminated with organic matter or moisture.

General Reference Works

Autotype Co., Ltd.—The A.B.C. Guide to Autotype Carbon Printing.

Hiet—Screen Process Production, 1936.

Neblette—Photography, Its Principles and Practice, 1930.

A. C. Horn Co.—General Information on Process Methods.

Patents

Few of the glass decorating processes are covered by patents. However, anyone contemplating the use of the silk screen process for ceramic work would do well to investigate this angle. The following list includes most of the important patents pertaining to silk screen decorating as it relates to ceramic work.

1,254,764	Jan.	29, 1918	Beck et al
1,444,531	Feb.	6, 1923	Steinman
1,490,400	Apr.	15, 1924	Owens
1,495,037	May	20, 1924	Patterson
1,526,928	Feb.	17, 1925	Owens
1,687,080	Oct.	9, 1928	Beck
1,706,038	Mar.	19, 1929	Owens
1,832,216	Nov.	17, 1931	Johnson et al
1,922,710	Aug.	15, 1933	Owens
1,518,863	Dec.	9, 1924	Lutz
1,651,474	Dec.	6, 1927	Scott
Re.16,048	Apr.	21, 1925	Scott
1,930,153	Oct.	10, 1933	Smith & Campbell
1,781,834	Nov.	18, 1930	L. F. D'Autremont
2,002,335	May	21, 1935	Barnard
2,005,809	June	25, 1935	Smith & Campbell
2,009,098	July	23, 1935	Smith & Campbell
2,014,372	Sept.	17, 1935	Brickell
2,014,373	Sept.	17, 1935	Brickell
2,018,989	Oct.	20, 1935	Wulf

[5]American Lecithin Company, Inc., Elmhurst, L. I., N. Y.

PUBLICATIONS RECEIVED

Crushing, Grinding and Pulverizing Equipment for the Refractories Industry. By A. F. Greaves-Walker. Published by the American Refractories Institute, Pittsburgh, Pa.

This bulletin is part of the material being written by Professor A. F. Greaves-Walker for the book on Refractories of the American Refractories Institute. Portions will be printed in booklet form from time to time before the book itself is published, not only to distribute information but also to obtain helpful criticism from Institute members and others connected with the industry. Any suggestions, particularly those based on plant experiences, should be mailed to S. M. Phelps, Mellon Institute of Industrial Research, Pittsburgh, Pa.

The Glass Industry of Western Pennsylvania, 1797-1857. By William Bining. The Historical Society of Western Pennsylvania, Pittsburgh, Dec. 1936.

An extremely interesting narrative of the early days in a great glass making district. The needs of the early Western settlers for glass plus the facilities for transportation afforded in this district by the Ohio and Monongahela rivers seem to have been the chief causes of the development of glass in Western Pennsylvania. Also described are something of the financial and legislative background.

MAY PLATE GLASS PRODUCTION

The production of polished plate glass by member companies of the Plate Glass Manufacturers of America was 19,437,246 square feet in May, as compared with 21,955,771 square feet produced in April, and 19,192,114 square feet produced in May, 1936.

REGENERATIVE FURNACE REFRACTORIES

By DONALD ROSS

A regenerative furnace is composed of many types and sizes of refractories, from the silica brick of the checkers to the massive blocks of the melting chambers. In considering the design and construction of a furnace, or its operation, one must include the properties of the refractories, their uses and limitations.

The present discussion is a series of statements, ideas if you will, concerning the refractories used in container manufacture. Some are the result of experience; others little more than conjectures, which time may disprove. But they are presented to encourage ideas and the expression of ideas on the part of others.

And there is need to exchange opinion among glassmen, however casual their theories may be. Usually, when there is a problem to be solved, the operating head has his operating data which he brings to bear upon the situation; but his data, quite inevitably is at least one step further removed from the job in hand than the very immediate experience of the tank tender. A more satisfactory and more complete solution of the problem will be reached if both men can bring to bear their combined experience and ideas—a cooperation which is promoted, often by a community plug of tobacco on the seat back of the tank. The refractory manufacturer might be included in a conference of this kind, for he has still a different background of experience. It is to just such an informal gathering of men on the job that I plan to sit down with here.

The furnace we are about to discuss should be located with an eye to the plant's most efficient and economical operation, and its design suited to the type of ware to be manufactured. Because we are going to make bottles, our machines will be assembled about the furnace. Our furnace will be the ordinary, cross-fired, open hearth (tank) furnace, which in turn is one type of reverberatory furnace. Compared with the iron-producing blast-furnace and its accompanying stoves (heat economizers), the reverberatory furnace of the open hearth (glass-melting tank) type is perhaps rather inefficient. If true, this is encouraging: for then we have a manufacturing unit that meets present competition, but which contains latent possibilities for improvement.

The hearth (tank) is supported on an iron frame, and it has regenerators situated at each side. The tank consists of a melting chamber, connected below its metal line by a "flow hole" to a refining or working chamber. Compared to many other types of reverberatory furnaces, this tank is relatively deep. The melted glass flows from the melitng to the refining or working chamber, and thence passes on to the forming machines.

We will leave the composition of the glass itself to the glass technologist. We will assume our tank is filled regularly and worked continuously. The temperature at the crown is maintained at approximately 2700° F., though if our executive and our tank tender are expert firemen, they may possibly maintain still higher temperatures on the pile of melting batch without over-heating the furnace parts and, more particularly, the tank blocks at the metal line. It is possible to maintain the metal depth substantially constant, giving an appreciable circulation to the bulk of glass—broad streams of hot glass flow over the mass of cooler glass and deep channels of hot glass extend down into it.

The foundation on which the tank rests must be solid, or the refractories cannot function satisfactorily. The refractories must not be blamed for losses caused by movement of the foundations. Above the foundations are the checker chambers, or regenerators. For some jobs chambers that are relatively tall and narrow are favored, while for other purposes short, wide chambers may be preferable. Efficient furnace operation is favored by checkers that do not clog, and that absorb heat at the maximum average rate per unit of check-chamber space between minimum and maximum checker temperatures. Such efficiencies in checkers are affected both by construction and by physical and chemical properties of the checker materials.

From the design standpoint: First, principal sections through the heat-absorbing checkers should be thin enough so that the temperature of their centers will vary sufficiently during a cycle to perform useful service. Second, the mass of heat-absorbing material per unit of checker chamber space should be as great as possible and still permit suitable flue space for efficient heating of the checkers. It is desirable to have the upward-facing surfaces of the checkers of such shape that dust will not collect on them. It may eventually prove that checker designs similar to those used in iron blast-furnace stoves will find use in the glass industry.

Concerning the physico-chemical properties of checker tiles: 1. They should be of material that will not shrink in use. Materials that shrink in use draw away from the walls of the chamber and permit a rush of hot gases down the resulting space without suitably heating the checkers. Furthermore, shrinkage decreases the area of the checker openings, thus intensifying the effects of clogging, and still further retards heating of the checkers.

2. Dense checker tile quite certainly have advantages over porous tile, even though this property has been difficult to evaluate in commercial practice.

3. Silica brick used as checkers have the advantages that they do not shrink in use, stand rigidly in place until the end of the fire, and wash clean so that checkers made of them are not apt to clog if run sufficiently hot. They have the drawback that, if run hot, they are fluxed away rather rapidly by basic dust and vapors.

4. Siliceous fire clay brick of low flux content have the advantage that they do not shrink appreciably and tend to remain clean. At moderate checker temperatures, a glassy layer forms on the surface, and retards further deterioration.

5. In the case of more aluminous checker tile, it is desirable that the porosity be low, otherwise, the tile will shrink in service. The porous aluminous checker has the further draw-back that, at certain temperatures commonly found in checker chambers, fluxes brought over in the hot gases penetrate it and bring constituents of it to the surface. Here they collect as "curls" and

rapidly clog the checker flues. High heats may melt such curls and cause this material to slump into lower portions of the checkers. If this process of internal deterioration has gone too far, the checkers so affected are apt to collapse at or near the temperature at which the curls soften.

The checkers may be the heart of the furnace, but the hearth (tank) is apparently the digestive apparatus. Four items of attack are chiefly responsible for the destruction of tank block:

1. Attack on vertical faces of tank blocks below the metal line is perhaps not excessively rapid if the structure of the block be mechanically good.

2. Attack at the metal line is at present perhaps the limiting factor in the life of most tanks. It is dependent on a number of factors some of which are operating problems. As the metal line becomes established, one type of semi-stability exists in the surface of the block below the metal line and another type above it. In case the metal line rises, the newly covered surface is rapidly attacked and crystals of corundum floating from it may cause stones in the glass. On the other hand, if the glass recedes below the established level, siliceous materials are gradually leached away from the exposed block surface and the residual alumina tends to be transformed into corundum crystals. Thus it is usually advantageous to maintain the metal line as nearly constant as possible.

If a small amount of sodium sulphate is used in the batch, a portion of it rises to the surface of the metal and keeps the surface free of the siliceous scum which is otherwise apt to accumulate on the surface of the glass in the melting chamber. Excess sodium sulphate floats on the metal and tends to collect against the blocks and destroy them.

As the temperature limit of the block is approached, destructive agencies become rapidly more effective. Hence, it is usually advantageous to maintain the metal line of the blocks suitably cool by the following methods: First, have furnace construction such that the upper edges of the flux blocks are protected under the superstructure, instead of projecting into the tank. Second, adjust the fires so that they play upon the melting batch and then rise into the exit ports, instead of being concentrated against the block at the metal line. Third, cool the tops of the blocks at the metal line from outside the tank. Such cooling can be accomplished to a degree by blowing air against the block. Water-boxes used for this purpose are usually ineffective. Contact of water-box with block is difficult to maintain. Furthermore, impurities in the water commonly "cake" the boxes. Both these conditions convert the water-box into insulation instead of a cooling agent. In cases where the blocks of partly worn tanks are examined, the portions in front of water-boxes are commonly thinner than other portions. However, if water-boxes are used, be certain that they are in complete contact with the block (preferably cemented contact) while the tank is at operating temperature, and that the cooling water does not cake the box.

3. Upward eating of downwardly facing surfaces is commonly rapid and destructive. In most cases, however, it is readily controlled by avoiding exposure of downwardly facing surfaces within the tank. Downwardly facing surfaces are usually upward eaten little, if at all, provided that the products of reaction of block and glass are retained in contact with the block.

4. Destruction of downward facing surfaces of flow holes, or "throats," between melting and refining compartments is, like metal line attack, one of the chief causes of failure of tanks. Although such attack apparently involves a number of features, it appears probable that upward eating is one of the major factors. The amount of upward destruction usually decreases rather regularly from the melting end to the refining end of the flow hole. Upward-eating cavities are commonly practically continuous on the downward facing surfaces of flow holes. The idea has become rather well established that the motivating factor in this corrosion is bubbles of gas in contact with the downward facing surface. Is it probable, then, that more gas is released from the glass as it is being drawn down in the melting chamber, than is released as it rises? In addition to upward eating, we should remember that much glass passes this relatively small area of block, and that any reaction-products of block and glass that get more than a short distance from the block are in all probability swept from it.

The life obtained from ports, upper-structure and crowns is perhaps largely a matter of design and efficient use of fuel. The aim of design and firing is to maintain melting temperature in contact with the pile of raw batch in the hearth, without excessive dusting, and at the same time to keep the furnace parts suitably cool. The number of square feet of melting area per ton of glass melted can apparently be relatively low without undue wear of the furnace, provided that flame gases do not impinge directly on furnace parts.

Open-hearth steel furnaces are commonly constructed with relatively great distances between inlet and exit ports. This feature probably aids efficiency and life of such furnaces. Is it possible that relatively great width of glass tanks would favor small area per ton of glass melted and long life of ports and port jambs?

The batch ingredients in the furnace gases arise largely from the sodium and calcium contents. Therefore, the chemical nature of the attack above the metal line is different from that below it.

Under existing conditions in tanks, best quality clay refractories serve in positions where the temperatures are not excessive. As noted above (under discussion of checkers) high alumina ware, particularly if very porous, is subject to sub-surface deterioration. In the tank, as in the checkers, silica brick remains rigid as long as it lasts, and withstands high temperature, but is only moderately resistant to dust attack.

An axiom among tank men is: "Silica brick may be used above clay refractories, but never place clay above silica." This is because the somewhat aluminous iron-bearing wash from clay is destructive to silica brick. An accessible place to study the service properties of silica brick is in the crown of a glass melting tank. To date, silica crowns hold their own against all contenders.

Let us now turn to the operating head and the tank tender. In connection with refractories, these two have much in common, for, although types and grades of refractories for specific purposes are fairly well established, new uses for a given type occasionally appear,

and, to a degree at least, each furnace is a law unto itself. It is commonly helpful also to have technical representatives of the refractories manufacturers sit in on discussions of such matters, particularly in case of the inspection. The proper use of refractories in glass furnaces, then, is a situation where sympathetic cooperation surpasses mere following of standard procedure.

The above discussion would not be complete without a conjecture into the future. If such conjecture is to prove useful, however, reader and writer alike must keep in mind that most conjecture is erroneous.

Let us first consider checkers. Some magnesite brick has been used for this purpose. Such brick are essentially alkaline material and as such should be resistant to the attacks of the dust from the furnace gases. The present-day bonding materials in magnesite brick, consisting largely of iron oxide, silica and alumina, are possibly the weak point of such brick for this service.

In the tank itself metal line resistance appears to increase, in degree at least, with the refractoriness of the tank block.

Possibly upward-eating might be lessened or eliminated by production of commercial glass from which gases would not escape. At present, however, commonly used types of blocks fall prey to upward-eating.

Pure magnesia is very refractory. Its crystalline form, periclase, is relatively inert. These facts suggest that, either in pure form or in some inert state with other ingredients, it may prove to have much wider application than present day magnesite brick. We can readily imagine that, should high-magnesia blocks prove satisfactory at the metal line, the next step might be to use magnesia as upper structure and crowns. This might permit of greatly increased melting temperatures.

• A very handy folder giving temperature conversion tables from degrees centigrade to degrees Fahrenheit and vice versa has been published by the National Bureau of Standards as Miscellaneous Publication M126. The fourth page of the folder contains a list of the chemical elements with their atomic numbers, symbols and weights and their melting points on the International Temperature Scale. Copies may be obtained from the Superintendent of Documents, Washington, D. C., for 5 cents each.

• The Northwestern Glass Co. recently adopted group life insurance protection of the contributory type for its employees. Each employee is covered for $1,000.

ILLUMINATING ENGINEERS TO MEET

The Illuminating Engineering Society will hold its thirty-first annual convention at the Greenbrier Hotel, White Sulphur Springs, September 27 to 30. A number of outstanding papers will be presented, and these together with the business sessions will afford an opportunity for frank discussion of many matters pertaining to the work in which the members are engaged. Prior to the formal opening Monday night, delegates will attend the Thirteenth Annual Lighting Service Conference in the afternoon. An innovation on this program will be a separate session devoted to residence lighting, conducted by women engaged in home lighting work.

NOTES ON JAPANESE GLASS ACTIVITIES

• Optical glass for microscopes, telescopes, cameras, surveying instruments and other high precision optical apparatus is being produced on a fairly large scale by the Osaka Industrial Experiment Laboratory of the Ministry of Commerce and Industry under the aegis of Dr. Toru Takamatsu, who developed his own process of manufacturing the glass from materials available in Japan.

Since there is available no sand with an iron content of less than 0.1 per cent he employs a pure white quartzite found in Fukuoka and Ehime prefectures. The rock is first put through a mechanical crusher and then ground into powder by an edge runner which is built of granite throughout. The powder is pickled and washed in hydrocloric acid to remove the iron, and it then has the following desirable composition:

SiO_2	99.63
Al_2O_3	0.26
Fe_2O_3	0.005
CaO	0.02
MgO	0.01
Na_2O—K_2O	0.05

Except for boric acid and sodium carbonate, which are not produced in Japan, Dr. Takamatsu uses domestic processing materials throughout. It is interesting to note that these chemicals are made in Japan with a very high degree of purity. Details follow:

Potassium nitrate	99.92
Barium carbonate	99.87
Red lead	98.23
Zinc white	99.82
Antimony oxide	99.77

These are blended in certain proportions, which are not revealed, and mixed in a cylindrical container with a capacity of 500 kg. The mixer is of steel and lined with zinc over the whole inner surface so as to prevent iron in the steel cylinder from entering into the fuse. One charge of the materials can be completely mixed in about 10 hours.

Dr. Takamatsu designed a special fusing furnace which accommodates only one crucible with a capacity of one metric ton. It is of the regenerative type, built of fire bricks that withstand temperatures higher than those corresponding to No. 36 Sagger Cone. It burns crude oil, and the flame travels over the crucible. The fuel is led into a mechanical burner equipped with fuel sprayer, while air is supplied through a pump from a separate regenerator.

The construction of the crucible was the most difficult job of all, and Dr. Takamatsu is said to have experimented for years before he succeeded in designing the present one, whose interior is lined with a special material to a depth of 3 mm.

Before the fuse is charged, the crucible is slowly preheated by a wood fire for four days and nights up to 700°C. Further preheating raises the temperature to 1450°C., which must be maintained for about five hours before the materials are poured. In this way one charge must be divided into at least eight parts, which can be poured within 24 hours. When the entire content is molten, it is agitated with a rod made of the same material as the lining in the crucible.

By Dr. Takamatsu's process the crucible is first cooled inside the furnace for about 10 days, and when the temperature drops to 100°C., it is removed into the open air so as to expend all the residual heat. The glass for optical purposes thus prepared must be cut into desired sizes and properly annealed.

The resulting product is finding widespread application with satisfactory results among makers of all kinds of optical instruments, and even miniature-camera lenses with an effective diaphragm of F/1.8 are made of the Takamatsu glass.

• Mr. Y. Hoshino, assistant professor at the Tokyo University of Engineering has succeeded in producing a plane polarizing filter of large size from a natural crystal occurring in the neighborhood of Mt. Iwaki. Considerable commercial possibilities are claimed for this process, details of which are unavailable yet.

• The Tokunaga Glass Company, Osaka, recently started construction of a factory at Mukden to manufacture bottles. This plant, capable of producing 250 tons of glass per day, will be operated by a separate concern established under the provisions of the Manchukuo commercial law. It is expected to be in production by next October.

• A great deal of attention, in engineering circles, is being focused on the new acetyl-cellulose process, described in a patent recently granted the Iwaki Glass Company. According to the specification, the cellulose acetate may be obtained by chemically compounding acetic anhydride and acetic chloride, which are dissolved in sulfuric acid, and some cellulose which does not dissolve in toluene or carbon tetrachloride. The product is used in the manufacture of laminated glass, the firm's specialty.

• The Shoko Glass Company, Tokyo, which runs a factory at Dairen with an annual capacity of 60,000,000 square feet of sheet glass, has recently completed an expansion program involving a second plant to produce 20,000,000 square feet. This firm, a subsidiary of the Mitshubishi and South Manchuria Railway companies, is capitalized at 3,000,000 yen. The expansion program was prompted by the increased demand from Manchukuo. Any excess will be exported to China and other Asiatic markets.

• Declining profits were reported by most of the chemical industrial companies for 1936, due principally to overproduction. Although the first half-year report for 1937 is not yet available, this tendency has not yet been completely offset. The following data were obtained through courtesy of the Mitsubishi Economic Research Bureau:

Business Development of Japan's Glass Industry

1935 Second Half		1936 First Half		1936 Second Half	
Profit Rate %	Dividend Rate %	Profit Rate %	Dividend Rate %	Profit Rate %	Dividend Rate %
24.2	18.2	23.2	18.2	20.8	14.1

• For many months past, the Japan Plate Glass Company has been expanding its factory at Yokkaichi, and still further extensions are projected. Productive capacity will be brought up to two million cases, which approximately doubles its present output.

THE USE OF THE GEHLHOFF AND THOMAS SPECIFIC EFFECT DATA

(*Continued from page* 229)

Table VIII and Fig. 6 deal with the property of the bending strength. The curves show that alumina is the only oxide that decreases the bending strength and that lime causes the greatest increase. This property is important in sheet glass, as the higher the bending strength the more stress the glass will stand in use.

As shown previously these data are, strictly speaking, only applicable to glasses that approach their parent glass in composition. With changes in the parent glass, the specific effects, in general, will change also. For example, the effect of adding barium to a soda-lime-silica glass is not necessarily the same as when it is added to the simple soda-silica glass. Commercial glasses, however, are similar to the soda-silica glass used as the parent except for their lower alkali and their lime content. If then the points on the curves that correspond to the lime content are located the approximate numerical value of the various properties can be determined for the soda-lime-silica glass. The effect of any oxide addition can then be determined from the curves and some conclusions can be drawn as to the probable effect on the soda-lime-silica glass. For example, in the case of bending strength the curve indicates that the bending strength would be increased by lime and decreased by alumina. In a soda-lime-silica glass, however, this decrease would not be noticed, as the amount of alumina (1-3 per cent) added would be small in comparison to the amount of lime (8-12 per cent) present in the glass. Such amounts of lime cause the numerical value for this property to be high and the slight decrease due to the alumina would be masked.

DR. WEYL APPOINTED TO PENN STATE

Dr. Woldemar Weyl of the Kaiser Wilhelm-Institut für Silikatforschung, Berlin-Dahlem, Germany, has been appointed Professor of Glass Technology in the Department of Ceramics at the Pennsylvania State College, effective January 1, 1938.

For the past six years Dr. Weyl has been in charge of investigations on glass at the Kaiser Wilhelm-Institut, and he is well known for his work on color and on gases in glass. During the academic year 1936-37 Dr. Weyl has been visiting Professor at the Pennsylvania State College and his given lectures at Ohio State, Princeton, and the University of Illinois. He is now in Germany.

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EQUIPMENT AND SUPPLIES

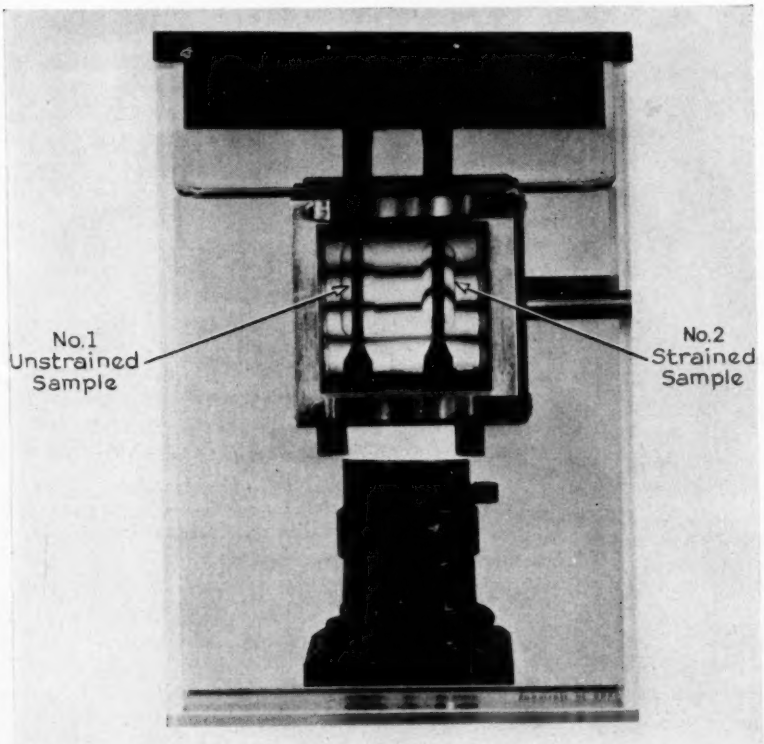
QUANTITATIVE STRAIN ANALYZER

An analyzer of the strain in glass, which is said to be much more sensitive than any other available apparatus, has been placed on the market by the General Electric Company, Schenectady. This unit is notable in that it gives directional and quantitative indications in addition to the usual qualitative measurements.

This analyzer utilizes two principles in providing indications. First, there is the accepted method of the distortion of polarized light by a strained medium and in addition, the use of the bi-refringent properties of a system of thin quartz wedges. Light from any convenient source, such as an ordinary incandescent lamp, is passed in succession through a polarizing screen, the specimen to be tested, the quartz wedge system and finally through an analyzing screen. These various components are so constructed and arranged that a number of distinct, straight, parallel lines are set up. These lines remain straight and parallel as long as the medium between the polarizer and the wedge combination remains unstrained, but the introduction of a strained specimen causes distortion, as is illustrated below. The degree of distortion is appreciable even for minor stresses, and the quantitative measurements are given by the magnitude. Qualitative measurements are indicated through the direction of distortion; compression indications being opposite to tension.

The size of the specimen is not very important; large objects may be tested by moving the specimen until all areas have been observed. In cases where the sample has curved surfaces, is not of uniform thickness, or is not clear, immersion in a liquid of equivalent refractive index becomes necessary. This clarifies surfaces that would appear opaque and reduces illumination losses.

The manufacturer claims that this analyzer has many uses both in the laboratory and the factory; from the control of production to the research necessary for determining optimum annealing practices. Examination by means of the strain analyzer is said to be convenient, rapid and positive.



Century Silica Co. has announced the opening of offices at 1220 Park Building, Pittsburgh, under the direction of Albert Frederick, Sales Manager. Their quarries and plant for crushing, grinding and preparing silica sand of all grades, are located at Foxburg, Pa.

General Refractories Co. recently elected S. M. D. Clapper Chairman of the Board of Directors. Mr. Clapper has been active in the company as president for several years. Floyd L. Greene has been chosen to succeed Mr. Clapper in the executive position.

NEW TRANSFORMER

The Acme Electric and Manufacturing Co., of Cleveland, have announced a new high-intensity mercury vapor lamp transformer which, when used with the proper lamps, is claimed to give greater lighting efficiency than ordinary incandescent lamps. In developing this new transformer the manufacturer evolved a new method of manufacturing cores, which includes the use of extremely thin laminations of silicon steel. Cool operation is insured by the use of oversize wire in the winding of coils. One feature of this transformer is the universal mounting design with removable mounting legs and thread coupling. Easy to reach terminals make connections for mercury vapor, incandescent lamps or both.

CATALOGS RECEIVED

Round Type Air Filters. Bulletin No. 500-2. The Northern Blower Company, Cleveland. A four page folder describing the "Norblo" line of round type air filters designed for continuous automatic operation. Sample installation drawings are given together with useful data on construction.

Power Pumps. Bulletin No. 6150. Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago. The design and specifications of the Simplex Self-Oiling power pumps. Constructional details are given in drawings and a cut-away illustration, with ratings in chart form.

Furnace Insulating Brick. Johns-Manville, 22 E. 40th St., New York. Describing the Johns-Manville J-M 20 brick and showing its use in insulating furnaces. Twelve sample illustrations of actual furnaces are given. Included are charts giving data on B.t.u. losses, sizes of brick for various conditions, and inner and outer surface temperatures.

Skids and Lift Trucks. Folder No. 322. Lewis-Shephard Co., Watertown, Mass. A pocket size folder giving constructional details and specifications of a variety of skids for interior transportation, with the lift truck designed to transport them.

The discovery that the No. 2 fuel oils are giving satisfactory service, although outside the carbon residue limits set by the Recommended Revision of Fuel Oils, Commercial Standard CS12-35, makes necessary further investigation before final acceptance of a standard. Further action is under the direction of the A.S.T.M. Technical Committee C.

Brown Instrument Co., Philadelphia, manufacturers of industrial recording and control instruments, has announced the appointment of E. B. Evleth as vice president and general manager.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	42.00	45.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)	lb.	....	....
Granulated	In bags, lb.	.021	.0255-.028
Powdered	In bags, lb.	.0235	.028-.0305
Boric acid (H_3BO_3) granulated	In bags, lb.	.0475	.0525-.055
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite (Na_3AlF_6) Natural Greenland (Kryolith)	lb.	.08½	.09
Synthetic (Artificial)	lb.	.08½	.09
Feldspar—			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	31.50	....
In bags	ton	33.10	38.00-40.60
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.085	10¼
In 5 Ton lots	lb.	....	.09
Less than 5 Tons	lb.	....	.095
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	....
Burnt (CaO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	....
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.25	2.25
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.065-.0675	.07¾
Hydrated 80-85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4)	ton	18.00	27.00
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb	95	....
In barrels	Per 100 lb.	1.35	....
In bags	Per 100 lb.	1.10	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	Per 100 lb.	....	2.25-2.65
95% and 97%			
Bulk	Per 100 lb.	1.275	....
200 lb. bags		1.34	1.39
100 lb. bags		1.375	1.425

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	....	.03½
Aluminum oxide (Al_2O_3)	lb.	.04	.05
Antimony oxide (Sb_2O_3)	lb.	....	.16¾
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03	.03¾
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	.07¾
Rutile (TiO_2) powdered, 95%	lb.	.10-.12	.13-.15
Sodium fluosilicate (Na_2SiF_6)	lb.	.06¼	.06¾
Tin Oxide (SnO_2) in bbls.	lb.	....	.60
Zinc Oxide (ZnO)			
American process, Bags	lb.	.06¼	.06½
White Seal, 150 lb. bbls.	lb.	.08½	.08½
Green Seal bags	lb.	.07½	.08¼
Domestic White Seal bags	lb.	.08	.08¾
Red Seal, bags	lb.	.07½	.07¾
Zircon			
Granular (Milled .005-.02c higher)		.07	.07½-.08
Crude, Gran. (Milled .005-.02c higher)		.03½	.04-.05

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.50-1.75
(Commercial, 25% Selenium)	lb.	....	.90
Cadmium sulphide (CdS)	lb.	....	1.50-155
Chromite	lb.	....	.0215
Cerium hydrate			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.21-.26
Cobalt oxide (Co_2O_3)			
In bbls	lb.	....	1.67
In 10 lb. tins	lb.	....	1.77
Copper oxide			
Red (Cu_2O)	lb.	....	.20¼
Black (CuO)	lb.	....	.18½-20¼
Black prepared	lb.	....	.22
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.0425
Black (Fe_3O_4)	lb.	.04½	....
Iron Chromate	lb.	....	.035-.05
Lead Chromate ($PbCrO_4$)	lb.	....	.16
Manganese, Black Oxide			
In Paper bags	ton	55.00	58.00-63.00
In Burlap bags	ton	57.00	60.00-65.00
In Casks	ton	59.00	63.00-67.00
Neodymium oxalate, 50 lb. drums	lb.	....	3.00
Nickel oxide (Ni_2O_3), black	lb.	....	.35-.40
Nickel monoxide (NiO), green	lb.	....	.35-.40
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	....	.09
Powdered	lb.	.09¼	.09½
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.18¾-.19¾
Rare earth hydrate			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	2.00
In lesser quantities	lb.	....	2.10
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06½	.07
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	....	.08¾
Sodium selenite (Na_2SeO_3)	lb.	....	1.80-2.00
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.50-1.55
Yellow	lb.	....	1.50-1.55
Sodium uranyl carbonate	lb.	....	.80-.90
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	2.25
Yellow orange	lb.	....	1.50

Polishing Materials

		Carlots	Less Carlots
Emery, Turkish	lb.	....	.07
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	....	.03
0, 0½, ½, 1.	lb.	....	.03¾
Putty Powder	lb.	....	.38-.42
Rotten Stone	lb.	....	.03
Rouge, Red	lb.	....	.14
Black	lb.	....	.16

(*Continued from page* 226)

a man's job, he is helped to put back his shoulders and look the world in the eye. This is the reason why the great protest of all the workers of the world is not for less work, but for more work.

"Hard Times" Unions

It is easy to see why the vertical unions have come into operation. They are very largely the result of depression and can be called "hard times" unions. The A. F. of L. craft unions can say to the unions in good times or bad, "We will help you to protect that relative distance between you and the common laborer which befits your skill and responsibility. As those at the bottom go up, we will try to help the top go up."

The vertical union hasn't got the cement to hold it together for the protection of a skill or a pride. It is a "hard times" union calculated to bring to a worker the utmost of job protection at the hands of an employer who has been hard pressed by hard times himself, and who has found it very difficult to make sure that all his foremen don't play favorites for the wife's nephew.

Fear—understood always in the measure of the pride in the job—offers a very great explanation of what has happened lately in labor relations.

When Fear Goes Out—Hope Comes In

Suppose that the losing of the job within the next year or two would not mean what it has meant for the last five or six years: Complete banishment into the utter misery of joblessness because of the absolute impossibility of getting any other job. What then?

I predict then that the employer has a much better break in comparison with his competitor, the organizer, because when fear goes out of the heart of this worker, hope comes in. When concentration upon the security of the job changes into the hope of opportunity on the job, when the matter of merely holding onto the job gives way to that everlasting wish of the American worker, to getting on in his job, then mere job protection isn't going to meet the needs of this customer-worker. Instead of brute force for protection, he must have the cooperation of somebody who understands.

This means that the whole problem of the executive becomes very different, yet very definite. There are then these ways executives can help men avoid labor trouble:

First, reduce fear to a minimum.
Regularize your jobs as far as possible.
Cut out favoritism.

Make sure to develop pride and justify hope through a program of watching very carefully your differentials for your foremen. Many foremen have become the forgotten men; their differentials have been sadly neglected.

Also watch the differentials for your skilled men. In many cases half the pleasure of being a skilled man has been taken away when the gap that used to separate him from the unskilled has been narrowed, simply because those chaps at the bottom were moved up.

Make sure to facilitate promotions. Even though a great many employers appreciate promotions, the chief obstacle ordinarily is the foreman, and the chief reason for that is that the foreman has always to work upon a budget. This means that when he loses his best man his costs go up higher than when he loses a poor man.

Most of all, I would urge the employer to let nothing happen that will serve to separate him from his contact with and his belief in the reasonableness of those individuals who comprise the general, average 60 per cent of his employee group.

The leader knows that those men are very hard boiled customers. They are saying all the time to the leader, "Yes, you have got us certain advantages, but we've paid our dues up to now, haven't we? What are you going to do for us in the future? We give you no advance credit for what you have done for us in the past. We will pay dues just so far as you merit continued dues."

If you say to me, "Yes, that is true, Williams, but you understand these men use intimidation on our employees and don't give them the free will to choose"—just put that down to the fact that your organizer is having trouble in maintaining these men on his list and that they are all the more ready to listen to you.

I have in mind one place where a company had agreements with fourteen different business agents and where six of those business agents were, not long ago, indicted and three of them sent to the penitentiary for bombing and slugging—not the members of the company; not the non-union members; but members of their own union who had fallen behind in their dues!

You can't convince me that the ordinary workers in that particular place had any respect for those leaders. You can't convince me that that management was at all justified in assuming that it was dealing with all of its workers by merely talking with those leaders.

The average, typical worker is not a Red. He is better educated than any other worker group in the world. He is more reasonable. He has more faith in the American scheme of things than you think. He is not radical. He simply wants to have exactly what you'd want under those same conditions: he wants to be able to think of himself as a man of fear in bad times, a man of hope in good times, and a man of pride in his job, exactly as you and I, at all times.

All of this is in line, therefore, with what happened over there in that mine in the Rhondda. The undermanager there in the mine thought these fellows were pretty hard-boiled and he would probably let the union leaders tell him these fellows were a pretty bad lot. He had gotten out of touch and really didn't know his men. But he went over to the fields of Flanders and fought throughout the Great War as the captain of a company made up of a hundred of his own miners.

As a result he put into operation a different kind of management. One night old Evan Pugh said to a group of us after the Bolshies had been trying to stir up trouble, "Yesterday, you understand, down there in the pit, the undermanager do say to me, 'Pugh, that do be a good job!' Und I do say to him, 'Mr. Undermanager, in 43 years of working in this pit—in 43 years—that do be the first time that any company mon do say to me a kindly word about my job like.' "

Then he went on to say, "Oh, aye now! Every mon do know that for a kindly wurrd he'll wurrk his bloody guts out. But every mon do know that no dog behave well for the man with a whip and every mon of feelin' and sensibility do know that for him the whip of the tongue and the lash of the lip be worse than any whip on any dog. Every man must have a chance to show himself the man on the job, now mustn't he?"

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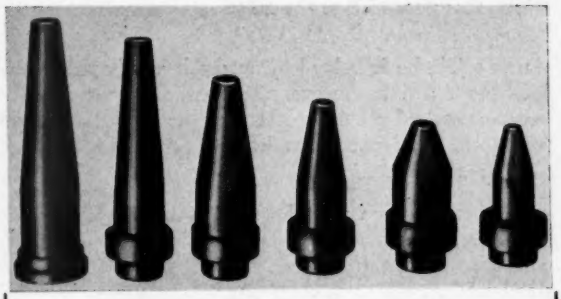

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